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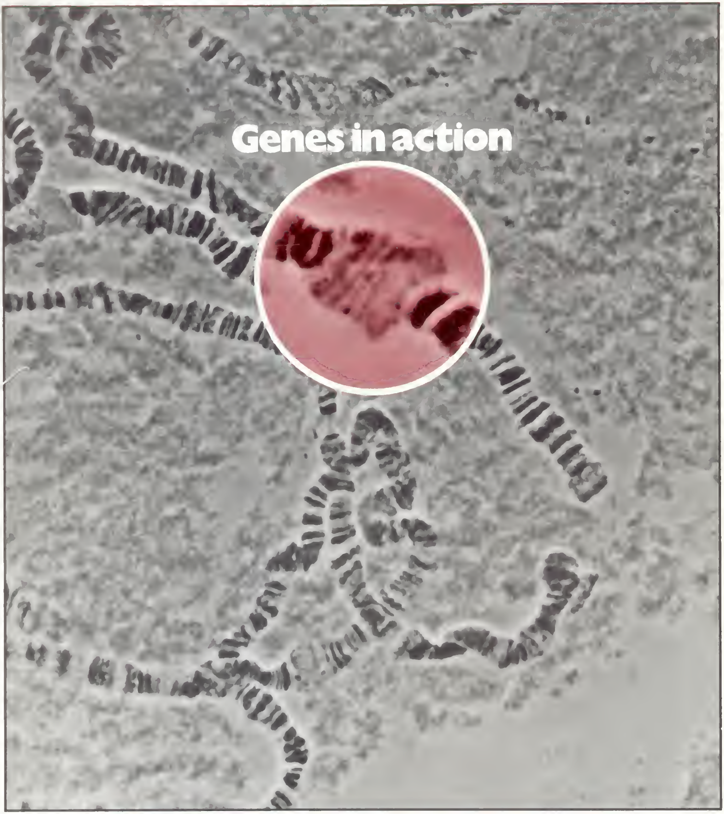

Genes in action

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News scientist.

TIMES PAST THE TIMES FUTURE

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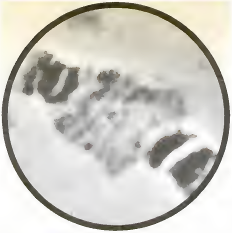

A fruit fly chromosome that has been switched on by the hormone ecdysone. A convergence of exciting new techniques in molecular biology is now yielding real insight into the mechanics of genetic control in higher organisms. Previous mysteries about the curious organisation of genetic material in these chromosomes, the apparent excess of DNA, and the "wasteful" transcription of genes, can now begin to be answered. A new series of articles begins on p 623.

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Comment

Wanted, 60 million dollars

The way has been cleared for the establishment of a billion dollar international fund for agricultural development (IFAD) following a United Nations conference which ended in Rome on Sunday evening. Nearly 90 nations at the four-day meeting adopted and initialled the agreement. It will be opened for formal signature once its target has been reached. So far nearly US$940 million have been pledged and an 18-nation preparatory commission has been set up to work out the machinery of the fund, which is now expected to be established early in 1977. Even if the final target is not achieved, a meeting in January is likely to suggest that IFAD goes ahead on the basis of existing pledges.

First proposed by the 1974 World Food Conference, the Fund is remarkable in drawing its resources almost equally from the industrialised and developing countries. The oil-exporting nations, for example, have pledged US$400 million from the OPEC Special Fund and the contributions of the industrialised nations total more than US$530 million. Furthermore, its constitution will be such that recipients, as well as donors, will have an important voice in how the fund's concessionary finance is used. For the first time, developing countries will have the majority say in the distribution of significant development funds.

When IFAD was first proposed, the industrialised countries treated the idea of another development fund with great suspicion. They were nervous about the motives of the OPEC members, who from the start were powerful advocates and supporters of the fund. The Food and Agriculture Organisation of the UN, the international agency traditionally associated with agricultural development, was also a little concerned that such a fund should be created under the auspices of the proposed World Food Council rather than under its own aegis. Although the organisation has since come to terms with this situation, it is still pressing for an early marriage—a prospect that has not so far found favour with the World Food Council secretariat. The prevailing view seems to be that FAO should not be in the business of managing international funds and should concentrate instead on the exercise of its technical expertise.

Meanwhile, the UN Secretary General and the President and Executive Director of the World Food Council have been given the task of drumming up the missing US$60 million. Where they will search is still an open question, although Austria might well be a reasonable start. Switzerland could be another source of cash. Its government (but not its voters) seem to believe that more funds should be made available to developing countries. On the day the Rome meeting came to a close, Swiss voters rejected a government proposed credit of 200 million francs (US$80 million) to the International Development Association, a subsidiary of the World Bank.

Tony Loftas

Wastage in the UK food system

However you choose to grow, process or cook food, you will waste some of it; efforts to avoid all waste would consume so much energy and manpower and pesticide as to be ridiculous, if not dangerous. But according to Robin Roy's *Wastage in the UK Food System,* released today by Earth Resources Research Ltd, Britain currently wastes 35 per cent of all food entering supplies.

The figure "35 per cent" is largely arbitrary; it depends on definition. For example, Roy suggests that 20 per cent of home grown food is wasted on the farm—which, as we grow about half our food, means 10 per cent of the total. But this figure comprises only the readily estimable pest and weed and storage losses. Few would doubt that Britain could, with more manpower and capital, easily double its present output. And again, we feed to livestock half what we grow and import; but if we were all vegetarian, and if we really tried to maximise production, Britain could possibly feed 250 million people, instead of only half of 60 million. This doesn't mean we should try to feed a United States full of vegetarians; it does mean that the amount by which you consider we fall short, depends on what you think we should be trying to produce.

Processors waste 6 per cent of what leaves the farms and docks; some, like the fish finger manufacturers, try to conserve their left-overs; others, like the cheese makers who throw away most of the whey which is 80 per cent of the original milk, do not. In all, the processors utilise only a third of what they could theoretically use. The biggest post-farm post-dock waster is the household; 6·7 per cent of all food finishes as kitchen and plate waste. This suggests a sad fall-off in techniques, for good cooks waste little; and unnecessarily high aesthetic standards, as whole fruits are rejected for small blemishes.

There are good reasons, of which balance of payments is only a minor one, to believe that Britain and all other countries should strive to be more self-reliant in food. This massive waste is a key area for improvement. And the best solution, as Roy suggests, is not to pile in more polythene and pesticide, but to re-instate the mixed farm, where crop waste automatically becomes animal fodder; to bridge the chasm between town and country, so that household wastes, for example, can be fed back; and to foster the old conservative cooking skills.

You cannot say the vast waste is absolutely wrong, because it fits in with our present aspirations and production methods very well. But it does suggest that our aspirations and production techniques are not in line with the needs of the crowded world.

Colin Tudge

Vancouver was no failure

Habitat's achievements will prove of more lasting significance than the West's defeat over Israel, which dominated the press coverage of the conference. Four points are particularly important. First, and perhaps most fundamental, was a clear statement that "it is the duty of governments to prepare spatial strategy plans". It is not so long since respectable opinion in Britain considered all planning to be worse than godless communism; many countries still do.

Second, and even harder for dogmatically capitalist countries like the US or Brazil to swallow, was a clause urging that "the use and tenure of land should be subject to public control", calling for "appropriate . . . agrarian reforms", and asserting bluntly that "the increase in value of land as a result of public decision and investment should be recaptured for the benefit of society as a whole".

Third was a remarkable set of resolutions supporting self-help and public participation: planning "must be designed to allow for maximum public participation", which "is becoming an indispensable element of a truly democratic process". That idea could have literally revolutional effects in many countries.

Fourth was Habitat's endorsement of the target for clean water in every urban and rural settlement by 1990, for which Barbara Ward had tirelessly campaigned. To the half of mankind without easy access to a tap guaranteed not to pass on dysentery, this is a 15-year target worth aiming for.

Jon Tinker

This week

Synthetic smokes for smaller fixes

Three in four cigarettes give smokers more nicotine than they actually want. This startling conclusion emerges from tests on cigarettes containing synthetic tobaccos by Drs S. Freedman and C. M. Fletcher of Hammersmith Hospital, London. Reporting their findings in *British Medical Journal* (12 June, p 1427), Freedman and Fletcher say: "Many smokers would be quite content and might suffer less harm to their health than at present if stronger brands of cigarettes were not available."

In the Hammersmith tests, 200 men smoked cigarettes containing 30 per cent New Smoking Material (a cellulose synthetic) and ordinary cigarettes for 20 months, without knowing which they were smoking. Half-way through the experiment, the 100 smoking NSM cigarettes changed to ordinary types and vice versa (a crossover trial). Twenty men were asked to save their stub ends for nicotine analysis.

In previous tests of this type, people changing to low-nicotine cigarettes generally altered their smoking habits (often by smoking more) to obtain the same nicotine fix. But in the Hammersmith tests there were no significant changes in cigarette consumption. Men who started by smoking brands delivering 1·4 mg of nicotine per cigarette smoked no more when they changed to the experimental cigarette giving only 1·08 mg of nicotine per gasper. As the two researchers say: "they appear to have accepted without demur a considerable decline in their daily nicotine intake".

Even more interesting are the results from the group which started the trials smoking the experimental cigarette and then changed after 10 months to the stronger type. Of a group of 17 such human guinea pigs (those whose nicotine intake was monitored by analysis of their dog-ends), 11 kept to their previous habits and thus upped their nicotine intake. But six dropped their intake to 0·9 mg per cigarette. Since they smoked no fewer cigarettes after the crossover, they must have taken either fewer or shallower puffs.

The NSM trials showed that synthetic smokes are acceptable—only one out of 200 men refused the experimental cigarette. This must be reassuring to tobacco companies planning brands with 30 per cent synthetic extenders. Earlier trials of mixes with more synthetics had shown them unacceptable to some smokers. But the observation that changing to synthetic smokes produced no changes in smoking behaviour is even more crucial to the tobacco giants. These results, say Freedman and Fletcher, "indicate that many smokers would be quite happy with cigarettes yielding only 1 mg of nicotine". Thus the argument that synthetic smokes would merely increase consumption, and therefore offer no real advantage over conventional brands, has taken a real knock.

Nothing, however, is that simple. In the same issue of *BMJ* (p 1430), Dr M. A. H. Russell of the Maudsley Hospital argues that "Smokers cannot easily stop smoking because they are addicted to nicotine, and to expect people who cannot stop smoking to smoke cigarettes that have hardly any nicotine is illogical. People smoke for nicotine but they die from the tar." Russell says that to cut tar intake by two-thirds would mean reducing nicotine intake from the current average of 1·3 mg down to about 0·4 or 0·5 mg, and this "seems unlikely".

He suggests, instead, that emphasis should be placed on reducing the tar content of cigarettes, while maintaining the nicotine fix they deliver. For example, by changing from Embassy Filter to John Player Carlton King Size, smokers could cut their tar intake by 20 per cent, without having to suffer any nicotine deprivation. □

Research fares as well as can be expected

Britain's science budget next year will be £216 million—that is, 2 per cent up in real terms over the 1975-76 figure. "Two per cent is well below the growth rate of the 1960s or the very beginning of the 1970s," Fred Mulley, Secretary of State for Education and Science told journalists last Monday, "but considering our economic difficulties, and the very many other claims on our resources, even this small advance is somewhat of an achievement."

Mulley told members of the Association of British Science Writers that additional funds from other government departments for research purposes would amount to £44 million, bringing the Research Council's total up to £260 million for the year. "For the future," the Secretary of State added, "I shall certainly do all I can to ensure that basic science receives its fair share of the funds available—but growth must depend on our economic performance."

The Advisory Board for the Research Councils is continuing with its broad policy aimed at gradually reducing Science Research Council (SRC) support for high-energy physics, astronomy, and space research. Even so, the Minister pointed out, the government will still be spending a great deal on big science. On present projections, the SRC's nuclear physics board will have a budget approaching £30 million by 1981, and its astronomy, space and radio board will receive £20 million—giving a total of £50 million for big science.

There is still apparently an arts bias among applicants for university places. But there seems to be no evidence that the sciences are considered "difficult". Over the past six years, for instance, there has been an increase of nearly 7000 boys and girls who have passed A level physics, over 6500 in A level chemistry, and a doubling (to 12 000) in A level biology. In 1974, for the first time, biology replaced chemistry as the second most popular science subject for boys. "I do not believe this has happened because biology is a 'soft option'," said the Secretary of State. "In fact, biology in schools today has become conceptually more difficult than before, and now includes molecular biology and statistics." □

Sail looks at the havoc wrought by steam

This coming Sunday 16 square-rigged vessels, all that remain of the functional tall ships, will leave Bermuda for Newport, Rhode Island, on the last leg of Operations Sail '76, a race to commemorate the US bicentennial. The race, which began on 2 May from Plymouth, has completed its first two legs, respectively to Tenerife, and from there to Bermuda.

Cadets aboard the tall ships, including the Rumanian *Mircea* shown here, are working for their keep in scientific ways as well as nautical: under the auspices of Unesco's Intergovernmental Oceanographic Commission, they are making regular observations of oceanic pollution. Reports of oil and plastic debris—expected to run into tens of thousands of sightings—are being logged aboard each ship. Accompanying naval ships are sampling the ocean for tar balls, collected for analysis under a joint World Meteorological Organisation and UN Environment Programme scheme. The ships are to join a grand water parade in New York on 4 July.

Some lessons from Guatemala's catastrophe

Housing design is the key to relieving both the death toll and subsequent hardships resulting from earthquakes. The truism was underscored yet again at a one-day meeting held at the Royal Society on Monday under the auspices of the London Technical Group. The theme of the multidisciplinary approach to earthquake problems was Guatemala's major disaster on 4 February this year.

While it is fashionable to discuss the prospects for earthquake prediction, in a preliminary review of this field, Professor D. J. Blundell of Chelsea College, London, could only conclude that, despite many promising innovations, effective forecasting was some way off—even for wealthy nations. Half-hearted measures could only lead to false alarms, a loss of credibility, panic, and economic devastation. China, he said, had been remarkably lucky in her prediction of a major earthquake in February. Without the fortuitous occurrence of what is called a "foreshock sequence" of characteristic tremors anticipating the main shock, all the careful monitoring work of the Chinese seismologists would have been in vain.

Associated Press

Other speakers at the meeting stressed more practical matters. Two, Hazel Weymes of the Department of Anthropology University College London, and Ian Davis of the Department of Architecture at Oxford Polytechnic, had recently returned from field studies in Guatemala. Their observations stressed other aspects than prediction.

It is a fact, said Hazel Weymes, that Guatemalans living in modern concrete houses did not suffer to any great extent. It was the poorer people whose heavy-roofed, unstable, rain-eroded adobe houses collapsed around them; or whose dwellings, perched precariously on ravine sides, were shaken adrift, who were the victims. The heavy roofs are a reflection of the need for thermal insulation in the tropical conditions; the ravine sites spell out a shortage of prime building land.

Both workers emphasised how, as unwanted food and clothing rolled in from relief agencies, the real shortages were in basic essentials like timber and corrugated iron to construct shelters. The Guatemalans are highly resourceful and Ian Davis made the point that labour is the most abundant and cheapest resource to hand after an earthquake. Add to that the psychological therapy inherent in starting to reconstruct, and the undesirability of emergency and temporary housing, and the answer seems clear—give them the tools and materials and let them do the job!

There are many other lessons from Guatemala's 'quake: bulldozers will help to clear mountains of rubble, but they won't salvage timbers, old reusable adobe, and other building materials. (OXFAM demonstrated how three demolished houses could be resurrected as one good one.) Language and cultural barriers, poor communications, lack of essential workers such as nurses—and of people to instruct volunteers—all contributed to greater hardship than necessary. And all of these problems would still have faced a population that had been successfully evacuated before the earthquake—though fewer would have died. □

Reformed alcoholics who drop their guard

A major furore is brewing among US experts in alcoholism following the release last week of a Rand Corporation study that suggests that a good proportion of alcoholics can return to social drinking without the danger of lapsing into alcoholic binges. Representatives of the National Council on Alcoholism, Alcoholics Anonymous, and other well-established organisations that deal with alcoholics, uniformally castigated the report as dangerous and misleading.

The report, prepared with funds from the National Institute on Alcohol Abuse and Alcoholism by psychologists David Armour and Harriet Stambul and sociologist Michael Polich, was based on follow-up studies on 1340 alcoholics six months and 18 months after they had begun treatment. The scientists found that 70 per cent of the patients were in remission but that, contrary to normal belief, only a quarter of those were completely "on the wagon." Most of the patients, they found, were taking occasional drinks—at a rate of the alcoholic equivalent of four beers every three days. The three scientists concluded that some alcoholics might be treated by more flexible approaches than total abstinence, although their findings did not indicate how to identify those who could return to social drinking.

So incensed was the establishment of alcoholic treatment organisations that the National Council on Alcoholism called a press conference on the report the day that it was released to the press. Experts made the point that the Rand study, which had not been subject to peer review since it did not appear in a medical journal, reached conclusions controry to those of other follow-up efforts on alcoholics. "It shows that a small group, under certain conditions, has been able to return to drinking," said council president John Maciver, "but is a preliminary study, too vague and not viable."

The major concern of the scientists was that every individual alcoholic would get the same message from the report: that he or she is one of the individuals who can safely return to social drinking. "My concern," said council member Nicholas Pace, "is that a lot of people will try to drink again, and a lot of people will die as a result." □

New Scientist **congratulates the following scientists who received knighthoods in the Queen's Honours List last week: Professor W. J. G. Beynon of University College of Wales; Dr G. M. Bull, director of the MRC's Clinical Research Centre, Northwick Park; A. E. Hawkins, chairman of the CEGB; F. W. W. Pemberton for services to agriculture; R. J. M. Swynnerton until recently chief adviser to the Commonwealth Development Corporation; Professor G. Wilkinson of Imperial College, London; Professor F. C. Williams of the University of Manchester; and Professor R. E. O. Williams, director of the Public Health Laboratory Service.**

California says no to 15

Californians voted not to impose new safety standards on nuclear power stations in the state by a 2 to 1 majority. Proposition 15 (see *New Scientist*, vol 70, p 523) on the ballot at last week's primary election was approved by 1·8 million voters, and rejected by 3·6 million.

Ostensibly an attempt to tighten up safety requirements, Proposition 15 was, according to the nuclear industry, a thinly disguised effort to put them out of business in the state. The industry spent over $3½ million in the campaign, matched by $1 million or so spent by the "Yes on 15 committee".

The result can hardly be described as an overwhelming endorsement of nuclear power. (In Britain, at least, support by a third of the electorate can bring a political party very near to holding office.) Both the nuclear industry and the anti-nuclear forces are preparing themselves for further nuclear referenda that will be on the ballot when the US goes to the polls to choose a president in November. The general issue is thus far from settled.

A new block on Olympics athletes who take steroids

Spot checks for anabolic steroids at the Olympics this summer will for the first time include a test for the intra-muscular steroids. This means that athletes who switched to these drugs after the introduction of tests for oral steroids will no longer get through the screening. In order to streamline the array of drug tests after each competition, the authorities are also to initiate pre-competition testing for steroids. All athletes are liable to be called on for a steroid test at any time after their entries have been received.

Although there have been suspicions that some athletes have switched to intra-muscular steroids, nothing could be done because no suitable screening test for these drugs was available. But now the radio-immuno assay test for oral steroids, which has been routine in international competitions since the beginning of last year, has been developed to pick up the intra-muscular drugs. The effect of the two steroids is the same, but the oral drugs are preferred because they are easier to take.

The immuno assay test for steroids, pioneered by Professor Ray Brooks at St Thomas's Hospital, London, heralded a breakthrough in the battle against steroids in athletics. Before the method was developed in 1974, the only way of identifying the drugs was by mass spectrometry which is costly, only processes a few samples at a time, and takes about a week to produce a verdict. It is therefore not suitable for screening hundreds of competitors. With the immuno assay test, 200 or more samples can be processed in parallel and the results come out in 30 hours. But any sample which is positive is still sent for confirmation by mass spectrometry. Usually about half the suspected samples are confirmed.

The search for a suitable screening test began in earnest after the Mexico Olympics in 1968 where the use of steroids was quite blatant, but nothing could be pinned on the culprits. Now the penalty for detection is a life ban from all competitions. So far two athletes—a Rumanian shot putter and a Bulgarian discus thrower—have been banned by the International Amateur Athletic Federation, but were recently reinstated after their appeals were upheld.

Unlike any of the other drugs used in athletics—amphetamines, for instance—the effect of the steroid lasts long after traces can be found in the body. Traces are detectable for up to two weeks after administration, but the effect on the athlete can last several months. This presents a unique problem for the authorities because, as long as the athlete gives up a couple of weeks before the competition, he is likely to get through any trackside tests. Spot checks throughout the year would be the only watertight way of controlling steroids, but suggestions for such a scheme have never been taken too seriously because of the enormous practical and political difficulties.

The main effect of steroids, taken with a high protein diet, is to increase mass, so they are mainly used by the weightlifters and the shot, javelin, and discus throwers where body weight is important. But when the sprinters started to use them around 1970, physiologists perked up because no experiment had ever shown that steroids did much for muscle power. The advantage of steroids, although well known to athletes, remained something of a mystery to the researchers. Last year, however, an experiment by Dr David Freed at Manchester University threw a new light on the action of steroids. He used athletes instead of volunteers and found that steriods did improve muscular performance.

Physiologists suggest that the crucial action of the steriod is through an immediate androgenic effect of increasing aggression and competitiveness. The fact that athletes are loath to come off the drugs at the time of competition lends credence to this behavioural theory, and implies that screening at competitions only will probably be enough to limit the use of steriods. □

One-way bottles rebound on Swedish management

The campaign for the right to work on socially useful products has now spread to Sweden. Workers at the Surte Glassworks have followed the lead of workers at Lucas Aerospace (see *New Scientist*, vol 69, p 239).

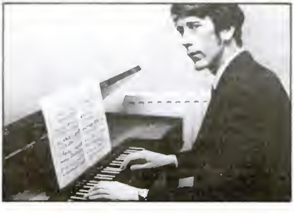
Surte was acquired in 1960 by the Swedish-owned Aktiebolag Plåntmannfactur (PLM). It is now one of three bottle producing plants operated in Sweden by this monoply.

In common with other European countries, there has been in Sweden a shift from returnable glass bottles to the more profitable, but environmentally less desirable, one-way bottles. These in turn are being displaced by "disposable" cans. Finally PLM announced that the Surte plant was to be closed within four years, and that 193 of the 500 workers were to be sacked by 1 May, 1976. The workers' response, as at Lucas Aerospace, was not merely to demand the right to work, but also to raise the social environmental issues involved.

To do so, they elected an *ad hoc* workers' committee, directly from the grass roots. This was a unique step in a country whose trade unions are even more bureaucratic than those in Britain, and where there are no equivalents of British shop stewards. The chairman of the workers' committee sees the issues involved as essentially political: "For PLM profits control the choice of products." Laus Hinzell, the head of PLM's glass division, denies this accusation. The company is simply accepting that the customer is always right, meeting "a need that was already there, a need for better packaging".

The workers' committee adamantly refutes this. "PLM has bought up the packaging market. First they bought all the tin producing companies, then the plastic, and they have a monopoly in glass, so they have been able to control the market towards the most profitable products", To support their contentions, the workers enlisted the support of economists, sociologists, physicists, and technologists from the Centre for Interdisciplinary Studies of the Human Situation at Gothenburg University. The Centre subsequently produced a report which upheld the workers' contention, and was used as the basis for a meeting with government officials.

Mr Lidbom, the Minister for Commerce, has now promised to contact PLM and attempt to persuade them to reverse their decision. The workers feel that, in the long term, stringent government measures are necessary to protect the community against the environmental pollution caused by undesirable packaging systems. Workers are now asking that the packaging industry be nationalised. A statement from the government is awaited. Surprisingly, the *ad hoc* workers' committee has decided to disband itself; "We have brought the matter to the attention of the government, and our work is done." It yet remains to be seen if their confidence in government support is misplaced. In the meantime, they are showing more trust in their social democratic government than the Lucas workers appear to be prepared to put in theirs. □



Hearing research

Professor Mark Haggard, 33, head of the department of psychology at Queen's University, Belfast, has been appointed director of a new Institute of Hearing Research to be set up by the Medical Research Council. So far without bricks, mortar or even a building site, the institute is intended to be a national centre to initiate and coordinate research into the impairment of hearing.

Vancouver diary

BY JON TINKER & ROBERT ALLEN

What are cities for?

Habitat was dominated by planners, architects, administrators, lawyers. The sociologists didn't make much of a showing. But one of the most provoking talks of all came from 74-year-old anthropologist Margaret Mead.

She claimed that we were becoming dehumanised by impersonalised bureaucracies and massed decision-making, and called for human beings to be "made whole again". She was particularly scathing about statistics: millions of tons of grain, data on population growth, thousands of rubles, megatons of cement—figures which "boggle the minds of both planners and consumers".

Communities, said Mead, should reproduce the whole of human society in microcosm. "Here is where it all begins, in hope as each new infant is born. And here is where it all ends, for each of us, as our lives are completed . . . We will cripple the next generation if we condemn them to live in a town where there are no old people or no children, no unfortunates in need of help and no handicapped in need of care, no people of a different skin colour, no one who speaks a different language, where everyone is rich or everyone is poor . . ."

Lucky UBC

The one undoubted beneficiary of Habitat has been the University of British Columbia, which is now the proud possessor of an exceptionally well-endowed human settlements audiovisual resources centre.

Most countries prepared for Habitat a 2-minute AV capsule describing their settlement problems, as well as longer 20-minute films. Many of these were dubbed into several languages by the UN, which also paid developing countries to produce the AV material in the first place. Total cost to the UN and the Canadian host government: about $5 million. If you add in the cost of closed circuit and cable TV facilities, the Habitat AV price tag was about $12 million.

What to do with the films and capsules after the conference was over? UBC has a human settlements resources centre (established all of several weeks before the conference opened), and British Columbia had been complaining for months that Habitat was bringing little but contumaceous foreigners into the province. So UBC signs with BC, BC signs with the Feds, the Feds sign with the UN. Somewhere along the line $6 million more is added to the deal, and everyone is very happy.

But what will they do with the capsules and the films? Ah, well, yes. Glad you asked me that question. It will be an archive. Constant temperature. Airconditioned. Keep the material undamaged for hundreds of years. Unique record of man's cities in 1975.

Trouble is, most of the material is straight propaganda. Splendid stuff for captive audiences at foreign embassies, but not much use educationally or for the media. And in any case, the UN originally only asked for copyright for the three-week conference period.

The most feasible use for all this material is as stock shots for new films or TV programmes. How many governments are likely to allow their films to be re-edited out of their present uncritical form? Surprisingly enough, 40 are already said to have signed over copywright to the UN and the UBC.

UN dinosaur

A bitter attack upon the megaconference spectacular appeared in *Jericho*, the Habitat daily newspaper. "Who could devise a more flauntingly hypocritical style of waste than that officials who cross the world and feast for a fortnight to change an ought to a should. . ."

Indeed, Vancouver was probably the last conference of its type. The Group of 77's insistence on ramming through an anti-Israeli resolution caused the US delegation to wonder publicly if America would participate in—and financially underwrite—another such meeting.

UN at work

Scene: the closing stages of plenary, last day but one. Time: about 1 a.m. Place: Queen Elizabeth Theatre, Vancouver. Cast: distinguished delegates of umpteen nations. Author: unscripted.

Cubans introduce amendment condemning use of planning to alter settlements pattern in territories occupied illegally or held by intimidation (ie the Israelis in Palestine). But since the proper place for amendments is in committee, the Cuban proposal should need two thirds majority. Pakistan proposes changing rules so that it only needs a simple majority.

Israelis say rule changes need two thirds majority. Tunisians point to a cunning "unless otherwise decided by the conference" clause in the rules, which they say means this rule change is within the rules. Algeria proposes all amendments should only need simple majority. Someone else proposes everything should only need simple majority.

Canadian president of conference, Barney Danson, is totally unable to cope. He makes repeated inconsistent rulings, allows the same arguments to be made over and over again, and after an hour and a half of procedural wrangling he rules that changing this rule is a substantive proposal and not a procedural one, thus requiring two thirds majority. It is blatantly clear that there is a two thirds if not a three quarters majority for any resolution on anything remotely to do with Palestine.

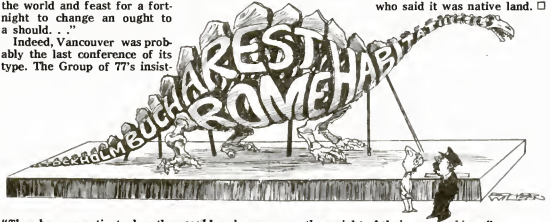
Danson makes an emotional speech saying Canada paid for the conference, that he feels deeply for Palestinian refugees but that politics mustn't be allowed to bend the rules. Puts this ruling to vote. Loses, vacates chair.

One of 23 vice presidents kept in wings for this eventuality now takes over. Distinguished delegate from Libyan Arab Republic starts to speak —in Arabic. No translation into English. Pause. Restarts speech. French translation comes over on English channel. Stops again. Protests to vice-president — in English. Starts his speech again—in Arabic, of course. Vice-president says he is advised no Arabic-English translation available.

Libyan delegate starts again. Pauses. Looks fixedly at roof of theatre. His aides look up as well. Translator descending from ceiling? Allah intervening? Everyone looks up. There is a large hole in the ceiling. Sparks and flames and smoke come out of it. Suddenly all the lights go out. Distinguished delegate from darkness proposes that in view of inadequate translation facilities and other unforeseen circumstances the session adjourn. It does.

MYOB

Vancouver was full of people debating other people's affairs. The UN passed proposals for national action, which 134 sovereign governments present will now ignore. The city council tried to call Habitat off altogether, then found it couldn't. And the Forum, the officially-sponsored unofficial counter-conference, debated what should happen to the Jericho Beach site, a collection of ex-seaplane hangars, which it no longer has any control over anyway. The strongest arguments were from those who wanted it as a pop concert centre, and the BC Indians, who said it was native land. ☐



"They became extinct when they could no longer carry the weight of their own verbiage."

Genes in action (I)

On the verge of a new era in biology

After years of being baffled by the complexities of genetic control in higher organisms, molecular biologists are now poised for a major advance. This article outlines some of the intriguing mysteries which have previously proved impenetrable and the new lines of research that will eventually solve them. Later articles will explore in greater detail some of the key areas of research

Dr Roger Lewin

The past few months has been a busy time for biologists probing the molecular basis of genetic machinery in higher organisms: a spate of meetings has kept them on the move, the most recent one being organised by the Dahlem Konferenzen in West Berlin. This unusually packed conference time-table reflects very accurately the flood of important results that is currently transforming ideas about gene organisation and expression. And to judge from the portents at the Dahlem meeting, that flood is about to swell into a tidal wave, the result mostly of a timely emergence of new experimental techniques.

There are two keenly productive areas of research at the moment: the first follows from the breakthrough in elucidating the detailed organisation of the nucleic acid (DNA) strands and their associated proteins; and the second rests on the newly developed ability to snip out segments of genes so that they can be studied in the relatively simple environment of a bacterial cell rather than in the daunting complexity of the nucleus of a higher organism. This latter is of course the central technique of genetic engineering, and it is clear that many laboratories are poised to launch scores of experiments once the problems relating to the control of such experiments are fully worked out. The prodigious output from these two areas is linking in with many other aspects of gene regulation, creating for the first time a real chance of an insight into the way genes are selectively active in controlling the development of complex organisms.

During the 1950s and 60s molecular biologists managed to work out many of the details of gene regulation in bacteria, *Escherichia coli* being the organism under closest scrutiny. In *E. coli* about 1000 genes are strung together in a single chromosome. Genes coding for proteins (known as structural genes) are turned on and off by the action of adjacent controlling elements which respond to regulatory substances in the cell. This, basically, is the scheme which earned Jacques Monod, Francois Jacob and Andre Lwoff their Nobel Prize in 1965, and they proposed it to be the probable basis of gene control in higher organisms too. In general terms this turns out to be correct, but for many reasons, some of which are clear while others are frankly abstruse, the whole system is many times more complicated in higher organisms.

One of the simplest differences between single- and multicellular creatures is that in the latter the cells become specialised to perform particular functions—they are differentiated. This means that in these cells not only does the genetic material have to contain the information required for the specialised function, but it also carries in a switched off form the genetic information for all the other specialised activities. For instance, in mammalian cells only about 10 per cent of the genome (the total genetic component) is active. As organisms grow from an unspecialised fertilised [illegible] information have to [illegible] up [illegible] place at the right time". [illegible]

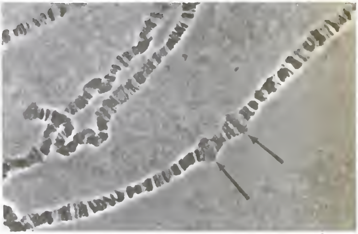


Figure 1 Chromosomes in the larvae of Drosophila *assume a characteristically banded structure. When genes are activated they form puffs (arrowed)*

described the early development of the fruit fly, *Drosophila*. After the egg is fertilised the nucleus begins dividing, going through eight divisions before anything else happens. At this stage the embryo is simply a single bag of nuclei. The nuclei then begin to migrate, forming a single layer on the inner surface of the bag, apart from one end where a clump of cells accumulates. Some of the cells in this group eventually form the germ cells in the adult fly. There is clearly a delicately balanced relationship between the state of the pre-germ cell nuclei and the position in which they find themselves. For instance, although these cells can be moved to another part of the "bag", and still finish up as germ cells, other nuclei moved into the clump do not become germ cells. However, if some of the cytoplasm which bathes the cells in the clump is transferred to another part of the periphery, the cells now in contact with the cytoplasm become germ cells.

Maps of active genes

Gehring and his colleagues are currently analysing the contents of the cytoplasm to discover what substances are performing the regulatory role. They have found two proteins which bind with specific parts of the DNA, offering the possibility eventually to map the areas in the genome involved in this early regulation. Similar events to this early stage are likely throughout the development of the embryo, events being controlled, probably, through a hierarchy of genes. Whatever molecular mechanisms are involved in this stepwise determination the final product—the differentiated cell—is remarkably stable in terms of genetic expression. In other words [illegible] cell to [illegible] tiated cell.

The [illegible]

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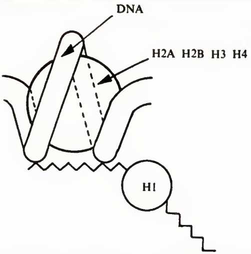

Figure 2 (Left) Diagram of a bead formed from two molecules each of the histones H2A, H2B, H3, and H4. The DNA coils round the histone bead, which has a diameter of about 106 angstroms. Separate beads are linked by histone H1.

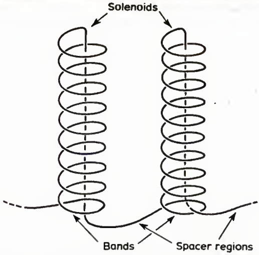

Figure 3 (Right) Diagram to show how the beaded chain may coil to form solenoids. The solenoids may form the bands in Drosophila *chromosomes, and the links the spacer regions.*

organisms reveals just how big those problems are. For a start, there appears to be no direct relationship between the amount of DNA in a genome and the number of structural genes present: for example, closely related species may differ by as much as ten-fold in their DNA component. The function (if any) of all this extra DNA poses something of a headache for molecular biologists, though "regulation" must be a good candidate. In general, the DNA of higher organisms can be divided into two types: the structural genes, and a class of sequences which are reiterated to greater or lesser degrees. The structural genes (unique sequences) are interspersed among the repetitative sequences, and together they must form some kind of regulatory complex.

The molecular manifestation of active genes is the migration of messengers (mRNA) from the nucleus into the cytoplasm where they are translated into proteins. That is straightforward enough. But what is something of a mystery is the huge amount of RNA churned out from the chromosomes, but which never leaves the nucleus. Are these molecules, which are at least ten times as big as the cytoplasmic RNA, precursors of the messengers, or do they perform some other obscure function? The answer to this is almost certainly linked with the problem of the superabundance of DNA in the nucleus. A model presented at the Dahlem meeting goes some way to untangling these problems, but we will come to that later.

The genomes of higher organisms are arranged into sets of chromosomes; in humans, for example, there are 23 pairs. Each chromosome is an amalgam of DNA and assorted proteins. It is through the proteins that both structural organisation and functional control are achieved. The proteins fall into three main groups: histones, which form the structural backbone of the DNA complex; non-histone proteins, which probably perform a selective regulatory job; and RNA polymerase enzymes, which transcribe the DNA into RNA sequences. All three groups have facilities for controlling the activity of chromosomes, the extent of which is only just being realised.

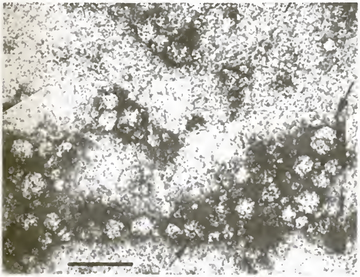

Figure 4 Chromatin beads visualised by interaction with anti-histone antibodies, making them swell. Arrows show bead connections; line is 1000 angstroms. (Cell, *vol 7, p 297.)*

The structural function of histones was, until just a short time ago, just a vague concept. But now several laboratories have demonstrated that they are at the heart of a surprisingly regular structure which undoubtedly has far reaching implications for the functional organisation of DNA. There are five types of histones, and four of them (known as H2A, H2B, H3 and H4) aggregate to form a bead in which there are two copies of each. Each bead, which has a diameter of about 106 angstroms, has a chain length of 200 base pairs of DNA associated with it, 140 of which are more tightly bound than the rest. If one were able to take the DNA out of a chromosome and stretch it out, it would look rather like a long necklace with no gaps between the beads (see Figures 2 and 4).

Currently there are arguments about whether the beads *can* slide along the chain, and whether indeed the chain has beads all the way along. The problem is that the close association of DNA with histone bead would be a severe impediment to transcription by the polymerase enzyme. To circumvent this hazard some people suggest that the bead may move out of the way, and then slip back, while others propose that actively transcribed areas of the DNA have no beads at all. One thing is certain, however, and that is that the beads could offer subtle ways of control. Given the number of variants of each histone type, and computing the number of combinations from which the bead octomer could be assembled, one finds that there are 136 different bead possibilities. Furthermore, the histone molecules have a special predilection for chemical modification at particular sites. There are at least five types of chemical modifications and 20 different sites, giving in total a huge variety of possible beads. As well as the many subtleties available, the beads might fall into three main groups: first, those which could permanently switch off DNA associated with them; second, those which might hold the DNA in a state of readiness; and last, a type which could allow active transcription.

This scheme fits into the model elaborated by Francis Crick at the Dahlem meeting. The model imposes a superstructure on the beaded chain, and at the same time would explain the existence of the nuclear RNA. The idea is that the chain is wound into supercoils, or solenoids as Crick christened them (Figure 3), with naked DNA running down the middle and on to the next coil. He suggests that the coils, which have a diameter of 310 angstroms and contain about six beads per turn, contain structural genes and associated regulatory regions. Coils would be of two types: some permanently switched off, and others in which the structural genes could be activated when the appropriate regulatory substances are available in the nucleus. The second type could be transcribed totally every few minutes, the idea being not to produce messengers, but to expose the controlling sequences in the coil to regulatory substances that might have arrived since the last transcription. When a gene is turned on it can be rapidly transcribed for as long as is necessary. In this scheme the large nuclear RNA molecules are equated with these transcripts, and are not seen as mRNA precursors.

In gross structural terms the solenoids may be the basis of the bands in the striped (polytene) chromosomes of fruit fly larvae. An actively transcribing solenoid would create the characteristic puffs seen on these chromosomes (Figure 1 and cover). The evidence for the reality of solenoids is as yet skimpy, and a good deal of imagination is required to see them in electron micrographs purporting to show them. Data from the technique of neutron diffraction are, however, more persuasive. Within a year this intriguing notion should be based on rather more solid information and rather less speculation. It is certainly very attractive, but it *may* have collapsed before that year is out.

A wide range of control proteins

The second group of proteins, with their unhelpful title of non-histone proteins, turns out to be a much more complex collection than was ever imagined. Edwin McConkey, of the University of Colorado, told the Dahlem meeting that new separation techniques show the number of these proteins in mammalian cells to be at least 400, once again displaying a vast potential for genetic control. Some of this group undoubtedly are involved in the packaging of the long DNA chain into the chromosome and with the changes in the state of the chromosome through the cell cycle, but most are almost certainly regulatory.

The techniques McConkey described are now so sensitive that it is possible to detect these proteins at the vanishingly small concentration of 50 molecules per nucleus; this is within the range that one would expect single gene regulators to be. The essence of gene regulation is of course a firm specificity between controlling sequences and regulatory substances. With the techniques of genetic engineering now at hand, it should soon be possible to start teasing apart the details of this specificity, a point which McConkey made: "Amplification of specific structural gene sequences in bacterial plasmids will, in principle, permit subsequent isolation of entire genes. This in turn will facilitate purification of specific regulatory proteins." The technique involves simply finding out which proteins stick to the genes.

The complexity of this group of controlling proteins is expanded by chemical modifications, as is seen in the histones. For instance, it has been apparent for some while that tagging phosphate groups onto some part of the protein chain may be involved in the activation of the regulatory function. In the current issue of the *Proceedings of the National Academy of Sciences* (vol 73, p 1174) Gary Stein, of the University of Florida reports that he has ". . . the first *direct* support for the theory that phosphorylation of non-histone protein is involved in regulating the availability of individual genes for transcription."

The last area of potential gene control, again not previously appreciated fully, lies in the polymerase enzymes that transcribe the genes into mRNA. In higher organisms there are three different types of RNA polymerase, each of which is composed of at least six subunits. The different polymerases perform different transcribing jobs within the cell: type I, for instance, is responsible for manufacturing ribosomal RNA; type III produces transfer RNAs, the molecules which help to assemble the individual amino acids for protein manufacture; type II enzyme does the job of interpreting structural genes (and probably the solenoids too). The multiple subunit structure implies possibilities for altering the specificity of the enzyme for different types of initiation sites on the DNA. Robert Roeder, of Washington University, told the Dahlem meeting that "The structural complexities of the individual RNA polymerases (6-10 distinct peptides) are surprisingly large and lend support to the hypothesis that the enzymes have more than a passive role in transcriptional regulation."

These three groups of proteins therefore offer a huge galaxy of potential control elements, most of which involve some kind of recognition of specific DNA sequences. The recent development in Cambridge, England, and Harvard, of relatively rapid techniques for reading the sequences of long DNA strands implies a real breakthrough in the potential understanding of the details of these protein/DNA interactions. There is clearly an explosion of important DNA sequences just about to burst on the biological community; the real problem will be in interpreting them. This technique is intricately related to the ability to snip out separately the DNA (genes and controlling elements) that are to be sequenced.

The current position therefore reflects control systems displaying far more flexibility than was ever imagined. This is rather reassuring as the subtlety of control implied by the exigencies of embryological development is immense! The temporal convergence of a battery of sophisticated tools for analysis inevitably will launch a new era in the understanding of these subtleties. ☐

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Computers by the thousand

Is the microprocessor the basic unit for the super-computer? Research underway at ICL suggests that many thousands of microprocessors, operating in parallel, will meet the demands of a number of giant machine applications

Dr Dennis Parkinson
is consultant on the applicability of the ICL Array Processor to scientific uses

Ten men can usually dig a trench 10 times faster than one man. The application of this principle is being studied—with the aim of producing super-computers — by integrating thousands of microprocessors into a unified system.

The defence programme, historically the main user of very large computers, is no longer a major influence in the design of super-computers. Weather forecasting, the energy programme, pollution control, and economic modelling are areas of research which are rapidly growing and producing requirements for ever bigger computers.

Typical of the growth areas in peaceful applications is the problem of predicting the weather. The European Centre for Medium-range Weather Forecasting (ECMWF) is being established at Shinfield Park near Reading to conduct research into methods for accurate weather forecasting up to 10 days ahead. The experts at ECMWF have made preliminary estimates of the computer power needed and predict that a computer six times more powerful than that (an IBM 370/195) used by the British Meteorological Office is required

Modelling of estuary flows has traditionally been done using large concrete models However, future work will require the modelling of much larger systems—such as the North Sea. Here the cost and inflexibility of concrete models is so great that future models will certainly have to be computer based. Computer models carry the additional advantage that measurements of flow can take place without altering the flow itself—something very difficult to achieve with traditional models.

The current design of sequential computers appears to be nearly reaching the limit of its performance capability. Speed-up factors of the order of two to five may be achievable, by using large-scale integration (LSI) microcircuits and improved heat extraction technologies. But some fundamentally new approaches are needed to produce computers that are orders of magnitude faster than the fastest sequential machines. There are well established reasons for these limits, the most important of which is the finite speed of electrical signals. LSI reduces the size of computers, and hence signal delays, but it cannot eliminate them entirely.

The separation of the store and the computational unit in normal computers leads to a requirement for a data highway to transmit instructions, data and results to and fro between the units. The speed of the data highway is an obvious bottleneck, and data rates many times those available from current technology are needed if dramatic increases in absolute power are desired. Two approaches are being adopted to overcome these problems: one is by the development of vector array processors, and the other the so-called cellular array processors.

The fundamental idea behind the vector array processor is to exploit the pipeline principle already used in many advanced computers. The basic principle of the pipeline is to allow overlapping in the various stages of the decoding, data fetching, and execution of an instruction.

The pipeline principle is not new and is often carried to considerable depth (the ICL 2980 has a seven stage pipeline). Vector array processors allow single instructions to operate on strings or vectors rather than single operands as with standard computers. If a single instruction acts on successive operands, then the pipeline can be used to overlap many more stages and so produce higher computing rates.

One of the difficulties that arises in discussing the power of super-computers is the lack of a suitable yardstick. For sequential computers, the MIPS (millions of instructions per second) unit is well established and is a useful unit, provided that the amount of work done by each instruction is approximately constant. By their very design principles, array processors can produce, with one instruction, results which would require thousands of instructions on a sequential computer—hence the MIPS unit is not valid. However, on rather tenuous grounds, one can maintain the MIPS figure to be some measure of the "total throughput capacity" of a computer and figures of 40-50 MIPS have been claimed for the CDC STAR-100 and the Texas Instruments Advanced Scientific Computer (ASC) in contrast to a conventional giant number-cruncher like the CDC 7600 at 10 MIPS. The STAR-100 and the ASC are the only vector array processors which have been delivered so far, but they have not been outstandingly successful. One of the main reasons has been the difficulty in adapting algorithms to make full use of the vector pipelines.

Although the vector array processors do offer a solution to some of the technological problems, they do not resolve all of them. For example, the data highway of the ASC has to operate 40 times faster than that of the ICL 2980 for a *theoretical maximum* increase of throughput of the order of 10.

Cellular array processors

The principle of the cellular array processor is to provide *N* computers (cells) controlled in such a fashion that they perform identical operations in parallel on various parts of the problem. If the task can be broken up so that it can be computed in *N* parallel streams, then the *N* cell computer is *N* times more powerful than its single cell.

The best known example of the cellular array processor is the ILLIAC-IV, consisting as built of 64 medium scale computers working in parallel. The most important difficulty in using the ILLIAC-IV arises from the necessity of interchanging data between the individual cells, because most calculations cannot be split into 64 identical but non-interacting sub-problems. Unfortunately, the design of ILLIAC-IV is such that the time taken to route data from one cell to another is rather lengthy, and so far few problems have been found which are well suited to its architecture. Since 1972, ICL has been working on a cellular array processor (see *New Scientist*, vol 59, p 634) which avoids many of the difficulties of ILLIAC-IV.

Semiconductor storage is already having a great impact on computer systems. Low-cost, high-speed and highly compact semiconductor memories can now be built using easily available mass produced storage chips. The price and cycle time of storage chips can be expected to continue to fall and very large fast stores may soon be practical and economic.

Up to now semiconductor storage has been used solely as a replacement for ferrite core store, but there are certain features of semiconductor memory which are not yet fully exploited. One such feature arises from the fact that each chip incorporates its own addressing mechanism, in contrast to core stores where one mechanism is used to address the total store. Future developments in computers

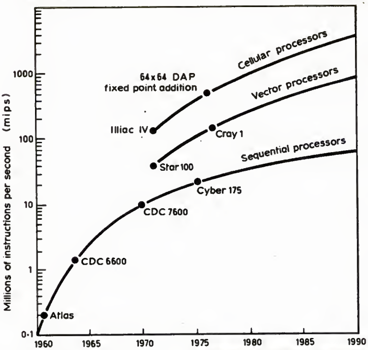


Figure 1 (above) shows the expected effect of improvements in circuit and component technologies on the performance of certain computer types (based on R. Turn—Information Processing 74 p 38, North Holland Publishing Co, 1974).

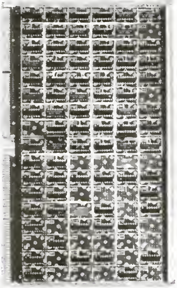


Figure 2 shows a typical array board of the Pilot ICL DAP. This holds 16 processing elements and associated 16k bits of storage—spare space is available to double the amount of storage

can be expected to exploit the parallel accessing capabilities of the storage chips.

The most explosive area in computers familiar to *New Scientist* readers is the recent growth of the incredible microprocessor. The ease with which large numbers of identical microprocessors can be produced, their small size, cheapness and flexibility is expected to have dramatic effects in many areas. The ICL cellular array processor exploits microprocessor technology to complete the circle and proposes microprocessors as the key to super-computers of the future. Figure 1 shows how improvements in circuit and component technologies can be expected to affect the speed of the various general types of computer.

The distributed array processor (DAP) approach is to build a cellular array processor out of many (typically 1000 to 65 000) elementary microprocessors. Although individually each processor is not particularly powerful, for suitable applications very large computer powers (of the order of 10 MIPS/1000 processors) can be achieved.

A major feature of the DAP is that the microprocessors are distributed among the store of a host computer—typically one processor to every 4k bits of store. The microprocessors, therefore, share their store with the host computer. This sharing of storage has a number of immediate benefits. One is that processing has been taken *to* the data—thereby resolving the data highway problem.

The most elementary microprocessor is a bit-serial processor—in other words, a microprocessor with all registers and data paths one bit wide. Bit-serial processing elements give some very important additional benefits. One benefit is that the storage of data in the computer may be matched exactly to the requirements of an application, and not constrained to multiples of some fixed word length. Thus problems which do not require very high arithmetic precision (such as image processing) can benefit by effective speed increases. Unlike ILLIAC-IV, bit manipulation processes (such as data routing) are well suited to the DAP architecture and are fast compared with arithmetic.

The choice of elementary bit-serial processing elements means that ordinary arithmetic operations must be built up by software from single bit operations, and so arithmetic on a single processor is very slow compared with conventional computers. However, the use of many processors in parallel gives the DAP its power. Using LSI techniques and advanced cooling methods, it would be possible to build a DAP with an array of 256 by 256 processing elements.

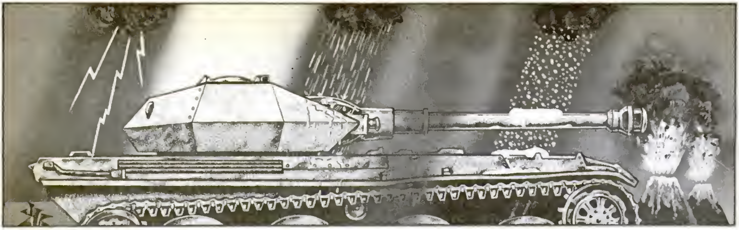
Pilot DAP constructed

The construction of a pilot DAP with 1024 processors was started within ICL in 1975. The processing elements could optimally be built using LSI techniques. For the small scale pilot equipment, however, standard off-the-shelf components have been used (adders, multiplexors, inverters). Figure 2 shows a typical array board of the pilot DAP. This board contains 16 processing elements and 16 bit storage chips (space is left on the board to allow the storage per processing element to be increased to 2k bits).

An application using the DAP will be loaded into the host computer in the normal fashion and initial serial computing carried out by the host computer. Appropriate data will be left in that part of the store which it shares with the DAP. When ever parallel operations are needed, the DAP is initiated and the host computer released for other tasks as in a normal multiprogramming system. While parallel operations are taking place the only resource blocked to the host computer is that part of the storage needed by the DAP application. When parallel operations are complete, the DAP signals the host computer which can then perform further sequential operations as required. Since the DAP shares storage with the host computer, no overheads are incurred in moving data into and out of it.

The original design of the DAP was strongly influenced by the requirements of a model for computing weather forecasts. A large number of problems dealing with the flow of fluids in one, two or three dimensions are also found to be suitable for computation on the DAP. The reason is because such flows are generally computed by means of models which consider the fluid as a number of cells interacting via various laws. One or more fluid cells are allocated to the DAP cells in such a way that the parallelism may well be exploited.

We have discovered that the DAP may be applied efficiently to a much larger range of problems than originally expected. But the full exploitation of array processors will require a re-examination of algorithms almost on a par with the re-examination that took place when computing moved from hand machines to programmed digital computers. The DAP approach promises considerable improvements in the cost/performance ratio for solving scientific problems. This potential cost saving has led to negotiations between ICL, the Department of Industry and the Science Research Council directed at financing the construction of a medium sized 64 by 64 array to be used for scientific researchers at a central facility. The first significant development in this direction has been the operation of the small pilot (32 by 32) array which is now working successfully. ☐



John Storey

The shape of war to come?

Unless we seek to ban such research now, it is almost certain that military scientists around the world will perfect methods for harnessing the forces of the geophysical environment for waging war. the *SIPRI Yearbook*, published today, spells out some of the awesome possibilities

Nicholas Valéry
reports from
Stockholm

Six months ago, *New Scientist* (vol 69, p 6) carried a cover story about the threat of environmental warfare. In it, Dr Frank Barnaby, Director of the Stockholm International Peace Research Institute (SIPRI), argued that there were two different impacts on the environment caused by war: the damage done during the fighting, either deliberately or incidentally; and the use of artificial changes in the environment as an actual method of warfare. Barnaby pointed out that though there is increasing concern for both of these phenomena, "the former is considerably more real than the latter." At the top of his list he put the use of herbicides and strategic bombing.

Now, in this year's issue of the *SIPRI Yearbook*, more detail is given about the actual techniques being investigated for modifying the weather, the ionosphere, the oceans, and for triggering earthquakes as a means of inflicting death and destruction on an enemy. As the SIPRI scientists point out, until about a decade ago, interest in these topics was directed purely towards their peaceful application, "but a considerable amount of research has been carried out recently into the use of methods of weather and climate modification as weapons of war."

Weather modification does not simply consist of altering the rainfall pattern alone. It also includes modification of fog, hail, severe storms, cloud electricity, and lightning. Fog, for instance, is formed when moist air is cooled. As the humidity approaches saturation point, small droplets of water begin to obscure visibility. This immediately suggests a means for producing fog artificially. If heat, for instance, is removed from the atmosphere, the humidity of the air will be raised to near saturation. However, this method requires large amounts of energy and is cumbersome. But, notes the *SIPRI Yearbook*, where the relative humidity is well below 100 per cent, fog could be produced using hygroscopic seeding materials. Because of their affinity for water vapour, the hygroscopic particles would initiate condensation. Even so, in both these methods, the chance of fog formation would depend very much on local wind conditions.

Six months ago, Barnaby suggested that it was perhaps the success of Soviet experiments on modifying hail clouds for peaceful purposes that made them interested in seeking a bilateral prohibition on environmental weapons with the United States. Academician E. K. Fyodorov, director of the Institute of Applied Geophysics of the Soviet Academy of Sciences and government adviser on environmental warfare, claimed that use of anti-aircraft guns and missiles firing explosives and materials for stimulating crystallisation of supercooled drops could help reduce the damaging effects of hail on crops by factor of four or five.

In the case of lightning modification, the Stockholm-based researchers note that though it has been suggested as a means of tactical warfare, it is simply not feasible at present—because the mechanism of lightning itself is poorly understood. "The limited frequency and extent of thunderstorms also makes lightning modification a very dubious weapon of war." However, one method of modifying lightning strikes, based on sudden perturbation of the electric field, seems to have had some success. "A method based on this principle has been used," says the *Yearbook*, "in which lightning is triggered artificially by launching small rockets carrying a thin steel wire, one end of which is connected to the ground."

Turning to the modification of hurricanes, the group points out that there are two key factors involved here. First, the transfer of latent heat from the sea surface to the air inside the storm is essential if a hurricane is to reach and retain significant intensity. The second feature is that the energy of the hurricane is released by convection in highly organised convection cell circulations. "Theoretically," says the study group, "it is possible to use hurricanes and other storms as weapons by enhancing, dissipating or guiding them by means of cloud seeding or other techniques. A controlled hurricane could be used against a country with an extensive coastline."

In order to generate a hurricane, heat transfer from the sea to the atmosphere is essential. Thus the evaporation from large areas of water could be modified by spreading thin layers of oil over the surface. "This technique, together with cloud seeding, could in theory be used to guide a hurricane to destroy enemy coastal defences." It must be emphasised, however, that the use of such phenomena as weapons is still highly speculative.

Tampering with the climate

Modification of the climate could be brought about mainly through changes in the radiative and thermal budgets of the atmosphere—by the introduction of aerosols, for instance. And the temperature of the atmosphere itself could be changed by altering the reflectivity of the Earth's surface by, say, covering regions with soot or asphalt.

One important method suggested for modifying atmospheric processes is the suppression of evaporation from lakes and reservoirs. This could be achieved easily by spreading a thin film of oil (monomolecular layer) on the surface of the water. (The evaporation from water surfaces is thought to depend on wind shear rather than on wind velocity. Thus suppression of evaporation in this way would seem really to be due to the effects of the oil monolayer on diffusion and convection rather than on vaporisation.)

"Modification of climate is on the whole still in the realms of theoretical possibility," says the SIPRI study, "but it is envisaged as a strategic weapon which could, for example, be used to destroy the enemy's agricultural pattern . . . It is thought that it may not be possible to achieve such changes in large scale atmospheric circulation in the coming two or three decades."

While the properties of the atmosphere itself are not particularly well understood, the mechanisms that drive the oceans and earthquakes too are even less understood. But there are phenomena, such as tsunamis, which are well documented. These extremely violent tidal waves often result when sediments and rocks perched on the continental shelf slide suddenly into the ocean deep. They can even occur as a result of earthquakes. "A series of phased explosions could be used to create such movements," suggest the Stockholm group. Another method of launching tsunamis might be to use nuclear explosions—either underwater or along the base of large ice sheets, causing them to slide outwards into the water. "If large ice velocities are achieved," comments the report, "this could create tsunamis causing enormous damage to coastal regions."

As far as earthquakes are concerned, there appear to be two principal methods for triggering events artificially. The first is by using explosions powerful enough to shake the ground in large areas and thereby trigger strain-relieving movements of the crustal material. In the second method, the strain energy is released by pumping in water, which acts as a lubricant and causes adjacent blocks of rocks to slip. (A series of small earthquakes were detected when liquid wastes were pumped underground near Denver.)

The report points out that the water technique for triggering an earthquake is rather clumsy and easily detectable. "On the other hand," it notes, "if the strain pattern of the region is accurately known, it may be theoretically possible to release the strain and cause an earthquake in that region by remotely placed, phased, or timed explosions." According to the modern theory of plate tectonics, however, this would seem to restrict earthquake modification as a weapon to certain parts of the earth—making it rather unlikely to be used as a means of warfare.

But perhaps the most exotic form of geophysical warfare concerns tampering with the electrical behaviour of the ionosphere, that ionised region of the atmosphere which extends from 50 km or so up to hundreds of kilometres above the surface of the Earth. Techniques for disturbing radio communication by "punching holes" in the ionosphere with nuclear explosions have long been discussed. So, too, have proposals for opening up lethal windows in the ionosphere to let in the short wavelength ultraviolet radiation (less than 300 nm) which is known to damage biological systems, causing skin cancers in man and damage to crops.

What is new is the suggestion that the natural waveguide between the ionosphere and the Earth could be used to propagate very low frequency (VLF) radiation through it in such a way as to affect the electrical behaviour of individuals' own brain activity. The alpha activity of the brain is characterised by rhythms with a frequency of around 5 Hz, which is rather close to the lowest resonant frequency, 8 Hz, of the ionospheric wave-guide. This type of radiation is difficult to detect because of its long wavelength.

Very little is known at present about the effects of weak oscillating fields on human behaviour. In some experiments the field strength used was around a few hundredths of a volt per centimetre, and the result of exposing human subjects to such fields for 15 minutes or so showed a small but measurable deterioration in the person's performance. Such fields, however, were a thousand times greater than the observed natural oscillations in the Earth's wave-guide. the *SIPRI Yearbook* comments: "If methods could be devised to produce greater field strengths of such low frequency oscillations, either by natural (for example, lightning) or artificial means, then it might become hypothetically possible to impair the performance of a large group of people in selected regions over extended periods."

Really, the most disturbing aspect of geophysical modification is that such operations could actually be carried out quite covertly. A state could seed clouds over its own territory, for instance, knowing full well that this would cause changes in the rainfall or snowfall pattern over a neighbouring country. And the state downwind might simply attribute such changes to natural fluctuation. "A more serious aspect of the development of geophysical warfare is that the threat to peace may not only come from actual use of such techniques, but from the fears and perceptions which states may develop about what others could be doing to them by the use of such techniques," says the *Yearbook*. "It may become possible to blame, rightly or wrongly, adverse changes in one's own weather, climate or other conditions on others."

Clearly, the prospect for gross interference with the weather or climate for military purposes is so disturbing to most people that the SIPRI scientists believe there would be massive support for a universal ban on geophysical weapons—"even more so because, unless banned, these weapons will almost certainly be developed."

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Is catastrophe theory dangerous?

Hailed as a mathematical revolution, catastrophe theory actually provides no new information about anything. And when used with incomplete data, it can lead to dangerously wrong conclusions

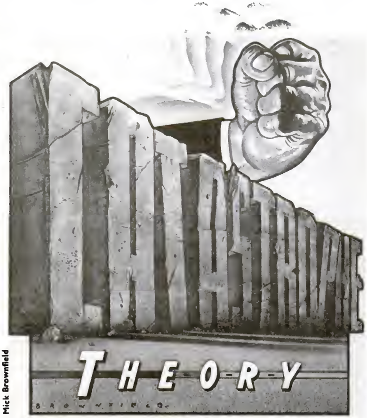
Dr James Croll is a lecturer in the Department of Civil and Municipal Engineering at University College, London.

Hailed as generating more "intellectual excitement" than all the "new mathematical theories . . . in the past few decades", and greeted as "a new qualitative language for servicing the inexact sciences", catastrophe theory is believed to offer "novel and deep insights into the world in which we live". Indeed, so grandiose have been the claims of its protagonists that one of their number recently felt moved to warn that "it is not omnipotent", and to provide some comfort offered the thought that "it is not the only thing in the universe"! *(New Scientist,* Vol. 68 p 447).

René Thom, who developed the theory, is aware that "many people are putting too much hope in the theory" *(Times Higher Educational Supplement,* 5th December, 1975). He seems to recognise that before any form of quantitative modelling is possible, it is necessary to have "some sort of underlying general law—like a physical law" governing the response of the system. Yet it is in the very areas in which the fundamental laws are least well understood that the theory seems to have received its greatest acclaim—certainly its greatest publicity. Even with our lack of knowledge of the fundamental laws, Thom is prepared to suggest that catastrophe theory "could be very useful as a way of modelling all sorts of psychological activities", and to understand these processes "one should try to model mental activities through geometric constructions and dynamical systems". This seems to contradict another view, expressed in the same interview, that without knowledge of the underlying law "the theory itself does not contribute very much, except . . . from a more philosophical point of view".

That a possible fundamental contradiction exists in much current thinking on catastrophe theory seems to be evident in the public statements of Thom. What he appears to be saying on the one hand is that before we have any underlying law or quantitative theoretical model, catastrophe theory cannot contribute very much. While on the other, that catastrophe theory is useful as a means of qualitatively understanding phenomena, such as those of the human and behavioural sciences, in which no underlying laws are available. Even catastrophe theory quantifications of economic systems such as the stock exchange are not ruled out by Thom, despite the absence of the underlying law.

One field in which sufficient quantitative understanding of the asymptotic behaviour is available, and in which the phenomenon that catastrophe theory so aptly classifies are of considerable practical importance, is the buckling of structures. The need for the sort of non-linear modelling with which catastrophe theory is concerned, arises in this field with the increasing tendency for designers to use high strength materials in the form of light, slender structures. Possibly the most recent of a long line of examples believed to fall into this category are box girder bridges. But there is now concern that some of the larger offshore oil platforms may experience this type of non-linear interactive behaviour. Considerable, although by no means complete, advances have been made in our understanding of the behaviour associated with these optimised structures. Some of the simpler phenomena are now able to be described on the basis of the fundamental laws of continuum mechanics, and some have been recently correlated with the classifications of catastrophe theory (Thompson and Hunt, *Journal of Appl. Maths and Physics,* Vol. 26, Fase 5, p 581). The question of present interest, although now hypothetical, is how catastrophe theory could have helped in the development of this understanding?



Mick Brownfield

A common denominator of most claims is that catastrophe theory provides us with a useful tool for interpretating empirical data, and that this interpretation, even if not quantifiable, would indicate the form of analysis and parameters that would be necessary to model the system. To substantiate this claim reference is often made to the experimental results obtained from simple models, such as an arch (Figure 1). These experiments show that the response, measured by the rotation at the centre, is largely governed by two parameters—the load magnitude and the eccentricity with which the load is applied with respect to the centre-line of the arch. The very precise results that can be obtained could then be quantitatively matched with the "best-fit" cusp catastrophe. In this case, the theoretical interpretation of catastrophe theory would be found to agree precisely with those obtained from a non-linear bifurcation analysis based on the laws of continuum mechanics. But it would be necessary to possess very precise quantitative data before it would be possible to even make a catastrophe theory classification.

In a more complicated problem, and there is good reason for supposing that many phenomenon outside the physical sciences are of this category, limited experimentation could easily give a false or at least an incomplete picture. Consider a long column made by bending a sheet of metal into the form of a hollow rectangular box. When loaded with an axial force applied eccentrically with respect to the centreline of the column, it behaves similarly to the arch. This data could be matched into the "best-fit" cusp catastrophe by finding how the coefficients of the asymptotic polynomial depend upon the two parameters—load and load eccentricity. We could then use our quantitative catastrophe model to help with the design of such columns —until a failure occurs.

Back to the laboratory to find, perhaps, that because the prototype column was fabricated in a different way to the laboratory models the square section had been considerably more distorted, relative to the wall thickness, than had the laboratory models. On testing more models with these new local distortions it would be found that the form of the cusp catastrophe is significantly affected by even small changes in the magnitude of a new parameter: local distortion. Our previous quantitative cusp catastrophe would on closer examination be found to have represented merely a projection of the true four dimensional hyper-surface. Precise quantitative empirical data could be obtained, and yet our classification of a cusp catastrophe might well have led to an incorrect and therefore potentially misleading modelling of the system.

There are also immense difficulties of trying to identify the type of asymptotic catastrophe from empirical data. Suppose in making our laboratory models one of the sides of the hollow box had been made from metal slightly thinner than that on the other three. Experimental results would be virtually unaffected by such a small change, and we would be tempted to again classify the behaviour as a four dimensional cusp catastrophe. The asymptotic behaviour of this now geometrically slightly asymmetric box column would, in fact, be like the asymmetrically stiffened plate in a class of simultaneous bifurcations termed "homeoclinal bifurcation". And, associated with this behaviour would be an asymptotic catastrophe energy function of the "hyperbolic umbilic" class (see Figure 2).

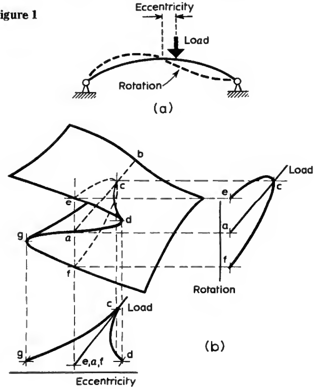
In other words, an almost imperceptible change in the physical characteristics of the system, which resulted in an almost imperceptible change in the physical behaviour, produced a complete change in the catastrophe theory classification of the phenomena. This severe limitation of asymptotic predictions is compounded when the nature of realistic experimental data is considered more carefully. What the reported catastrophe classifications of, say, the theoretical buckling of a stiffened plate do not make clear is that for the types of small imperfections experienced in practice, the asymptotic predictions of behaviour become of doubtful relevance.

In the more important highly optimised structures, even if precise quantitative experimental data is available, this data could not be regarded in any sense as asymptotic. Indeed, for a number of very important cases in structural buckling, such as the classical problem of an axially loaded cylinder, the asymptotic bifurcation predictions are more in the realm of theoretical abstraction than empirical reality.

Basic questions

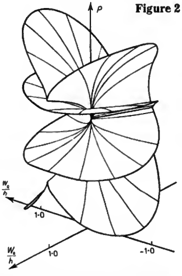
More than just raising doubts as to how catastrophe theory would have assisted in one branch of applied science, these examples pose questions which are central to the whole philosophical basis of catastrophe theory. To make any form of definitive catastrophe classification from empirical data is exceedingly difficult and would require data of extreme precision. Even then there would be no guarantee that the asymptotic classification is correct unless a fully validated theoretical law is available. Such a state of affairs confirms one of Thom's views that catastrophe theory "does not allow . . . quantitative modelling". Unless, of course, the quantitative model is already known. And it is also perhaps worth stressing that it is the experiments themselves that indicated which parameter and degrees of freedom are of importance and the form of analysis that would be necessary to provide a theoretical modelling of these experimental events. This contrasts with a widely shared view that catastrophe theory itself somehow yields this information. Finally, the experience of structural buckling shows that to make a catastrophe theory classification on the basis of incomplete or inaccurate empirical data could be extremely dangerous. All of which means the belief that catastrophe theory "gives scientists an analytical technique for providing a qualitative interpretation of . . . events" (Thom, lecture at French Institute, London, 1975) needs to be seriously challenged. Without precise and complete quantitative information a catastrophe classification can certainly not be justified, and if made must surely be regarded as specula-

Figure 1



Catastrophe theory is René Thom's method of looking at systems with sudden discontinuities. Thom's theorem implies that in the neighbourhood of a given point, there are only seven types of elementary catastrophies. Loading an arch corresponds to a "cusp" catastrophe (Figure 1, left). The surface in Figure 1b represents all possible static equilibrium states, relating load, rotation, and eccentricity. Only the centre sheet (described by g, a, d, and c) is physically possible, however. If a heavy load were moved from the centre of the arch (a in the diagram), the catastrophe—the failure of the arch—would occur when it reached g. Catastrophe theory backers hope that graphs such as this will lead to a better understanding of any system which shows sharp transitions. But identification of the correct catastrophe graph requires precise quantitative information. For example, a hollow box would appear to behave like the cusp catastrophe shown in Figure 1. Yet an almost imperceptible change in its physical characteristics produces a complete change in the catastrophe theory graph, leading to the hyperbolic umbilic of Figure 2.

Figure 2



tive. As such the geometric interpretations of catastrophe theory join a long line of scientifically useful speculation techniques. But in providing an aura of scientific respectability by apparently "giving scientists an analytical technique" there is a danger that the speculations based upon catastrophe theory might come to be regarded with greater credibility than other more explicitly intuitive methods.

This danger is particularly acute in the so-called "soft sciences". In the *Times Higher Education Supplement* (THES) interview, Thom claimed that social behaviour is one of the examples "in which a picture based on the ideas of catastrophe theory gives a very nice qualitative understanding". But forgetting for the moment these and other rather over-optimistic conceptions of the potential of catastrophe theory, it is possible that it could make some contribution to fields like economics, sociology and psychology by highlighting the misuse of linear statistics in these fields. If one is observing an inherently nonlinear process, such as the highly optimised and parametrically inter-connected processes of the "soft sciences", then no amount of linear correlation between the statistical parameters will yield meaningful results. Or, in the language of the catastrophist, "no approach which uses any kind of statistical averaging will locate a multi-sheeted graph, even if it actually occurs, because each layer of sheets will be replaced by a single sheet in the average position". If catastrophe theory has contributed to reinforcing this message, it will have performed a useful function. However, if catastrophes are to be considered "as less important as theories then they are evidence of the inadequacies of many current attempts to apply mathematics in the soft sciences" *(New Scientist*, Vol. 162, p 447), one wonders if it is really necessary to mystify this basically simple message in the jargon of topological theory? But even if this use of catastrophe theory is justified, it would appear that some are extending the case too far, for it has been proposed that in processing the necessarily in precise statistical data "one must look for probability distributions with multiple peaks, and use these to construct the (catastrophe) graphs". But identification of the correct catastrophe graph requires precise quantitative information. Moreover, such a classification would require an ability to exercise careful control over each of the parameters which is not at present, and one hopes will never become, possible in the human and behavioural sciences. So that to classify imperfect statistical data as a particular form of catastrophe without such complete empirical understanding must remain firmly in the realm of self delusion.

Despite the attractive asymptotic classification that catastrophe theory affords, it can in no way provide information about anything that is not in one form or another already available. And to attempt a catastrophe theory classification on the basis of incomplete empirical data, which may in any case not conform with the asymptotic limitations of the classification, to enable qualitative pictures to be constructed runs a severe risk of over-stepping the bounds of scientific rationality. If the failure of engineering structures tells us anything, to continue to call upon the experience of the civil engineer, it is that disasters are too often caused by the designer using, without full understanding of its limitations, a theoretical model in situations where the model is either incomplete or inappropriate. That similar tendencies could be occurring in the present developments in catastrophe theory is not beyond the bounds of possibility. By mixing up the processes of modelling and speculation it is conceivable that if some of the less than humble claims for the potential of catastrophe theory are taken at all seriously in the "soft sciences", the scientific method could again find itself being used to merely reflect ideological pictures of the world we live in and in the end justifying rather than interpreting the social order. □

René Thom—creator of catastrophe theory—replies

Dr Croll's article is probably a healthy reaction to the misunderstanding created by the overenthusiastic popularisation of catastrophe theory, and to the extravagant claims of some of its champions. Personally, however, I would deny Dr Croll's accusation of self-contradiction. Although, as a mathematician, I have never been too fussy about rigour, I feel he has misunderstood my position.

I have constantly repeated that catastrophe theory is fundamentally a *qualitative* theory. Quantitative modelling in catastrophe theory should be considered exceptional, and applicable only when the underlying physical (or mechanical) laws allow one to do it with absolute certainty. In that respect, I fully approve of Dr Croll's warnings about fitting a catastrophe scheme quantitatively to a given empirical situation (see my controversy with E. C. Zeeman on this point in *Warwick Symposium on Dynamical Systems*, Springer Lectures). Moreover when the situation is fully amenable to quantitative modelling the use of catastrophe theory is dispensable —as the catastrophe can be deduced anyway from the underlying equations. It would, nevertheless, be going too far to reject from the outset any possibility of making a quantitative fit of a catastrophe scheme to given empirical data; but such a procedure should not be more (nor less) trusted than any other approximation method used in numerical analysis.

So what may be the role of *qualitative* modelling? Certainly not the prediction of experimental results: any useful prediction always involves quantities, if only the time and place where the "catastrophe" is about to take place. But qualitative modelling may provide new insights into the underlying mechanisms of a phenomenon. It may also suggest new changes in the control parameters, and hence new experiments; or it may introduce analogies with other situations in the same discipline, or even in disciplines very far away from the original one.

Whether such an activity—which does not lead by itself to any practical result—should be considered as "scientific" or "merely philosophical" is a matter of definition. Dr Croll seems to adhere to the epistemological opinion prevalent in the Anglo-Saxon world that only those theories which produce practical results may be termed "scientific". I believe myself that those who hold that there is a sharp demarcation line between what is science and what is not may themselves be victims of a somewhat simplistic illusion.

It is quite true that this qualitative use of catastrophe theory—which is by no means confined to the taxonomy of the seven elementary catastrophes as popularisations often imply and as Dr Croll seems to believe—may lead (it has already led) to all kind of products from the most arbitrary analogies to the most interesting and profund considerations. Catastrophe theory is not a "scientific" theory; it is a language, and as with ordinary language every author will use it to his own taste, with his own "style". Readers will have to be warned not to accept all these attempts uncritically; but it will be a happy effect of Catastrophe Theory if it helps to dislodge the dogma of certainty and unfallibility attached up to now to the "scientific" tag.

Catastrophe theory not the only thing in the universe? I think the formula inappropriate. As soon as any discipline has reached the stage of being a "morphological theory", that is as soon as it offers a corpus of forms to be studied, then catastrophe theory may be applied. There is no *a priori* limit to its possible application. But the price it has to pay for this generality is a degree of ineffectiveness. Catastrophe theory may be applied, I believe, anywhere in science. But whether such an approach will be *effective* (either in the pragmatic, or even in a more conceptual sense) no-one can tell. But as in the "soft sciences" we have nothing better, why not try? *René Thom*

Danger of cats in the home

A warm summer and increasingly cosy homes are encouraging a population boom in cat fleas—a development more harmful to humans than to cats

Tim Robinson
is a freelance
writer

Cat fleas are a growing problem—for humans. Although in theory they will bite people only when they are literally starving to death (and only about half the human race is allergic to the bites anyway), in practice they can have a predilection for human blood even Dracula would admire. So bad has the situation become the Health Education Council has recently produced a film for public viewing on the life cycle and habits of the cat flea.

There is no human flea. The creature blessed with the title more properly belongs (or rather belonged, being virtually extinct) variously to foxes, badgers—even hedgehogs. Among British fleas, it is (was) alone in being able to breed on a diet of human blood. However, because it preferred cool damp conditions, modern houses, increasingly dry and warm, are not to its liking. Unfortunately, these conditions, conferred by snug dry carpets, foam-filled chairs, and central heating, are extremely favourable to the cat flea, now possibly the biggest domestic insect pest.

It seems that cat fleas irritate their natural feline hosts only minimally when they bite, a fine testimony to their adaptation as a parasite. If they did cause distress the cat would pursue a much more vigorous campaign against them. Humans react precisely because they are not the natural host (as do dogs, another new target for cat fleas). The allergy is learned; it can be painful, uncomfortable or simply itchy. Eventually one becomes desensitised, although one of the few biologists working on fleas in the UK took five years to do so.

A cat may carry as many as 100 fleas with it at any one time, but as it moves between several "nests" within the house the animal may maintain a total flea population of close to 2000. The female fleas lay between six and eight eggs every second of the day, in and around the cat's "nests". The eggs hatch into larvae, which feed among dust and dirt; the larvae pupate; and finally, the young adults seek a host from which to secure a regular two meals a day.

Humans can be hosts too

The host is any object of about the right weight moving near the nest—humans come into this category. To bite people they have to be voraciously hungry because it literally makes them sick. The danger is that after a while cat fleas may develop a means to control their nausea, and then, possibly, to breed on human blood. If and when that happens we will have a new version of the original *Pulex irritans*—the "human" flea.

Fortunately, cat fleas do not carry any serious disease. However, it is possible to catch the dog tape worms via a cat flea. This particular intestinal worm lives happily in cats as well as dogs—or in people, usually children. Like most internal parasites it has a complex life cycle. One stage can involve the worm larva living inside a flea, whereupon it makes the flea sufficiently ill to slow it up enough to be caught. This is what the larva wants because there is a good chance the animal will bite the flea open in its mouth allowing the larva to escape. Normally it would then begin a long journey to that animal's stomach. If, however, the dog or cat licks a human—probably a child—and if that child then transfers the saliva at a later stage to his or her mouth the tape larva can once again find its way to a stomach. Doctors have recently been more worried that this happens directly, children picking up eggs via the tons of dog faeces raining on our cities. A flea intermediary, though less likely, is still feasible.

A cat flea, a growing domestic pest

In general cat fleas are just a nuisance, whose irritating ugly bites can cause a great deal of distress. And it is a battle to get them out of a house once they have established themselves. Partly this is because the pupal stage can wait for a year before hatching, and during this time no known "safe" insecticide can penetrate its shell. Partly because it is sometimes difficult to find all the places cat fleas may have lodged. But the point to be made is that dusting the cat or giving it a flea collar is not enough. Spraying of all likely spots has to go on for at least four months, preferably longer, or an insecticide with residual powers must be used. Now that DDT is considered dangerous, Pyrethrum is often substituted. Unfortunately it doesn't last very long. A new ICI product—Actelic—may be the answer, as it is claimed to have long residual effects, but it would be best to spray a number of times anyway.

But, physical problems aside, the biggest barrier to controlling cat fleas could be a mixture of public indifference and embarrassment. As with the recent outbreaks of head lice in schoolchildren, the discovery of a room full of cat fleas, and the likely concomitant ugly red bites on (usually) lower legs, could occasion a heavy silence rather than the vigorous attempts needed to de-infest. The Health Education film may—if it gets a wide enough showing—help people realise how big the problem is. Professionals too, like doctors, need reminding that some of the bite marks they find on their clients, could be due to cat fleas, rather than mosquitoes or any other biting insect. In the end the question of how far keeping cats inside houses is desirable, like the recent debate over dogs in cities, may have to be raised. If that happens one suspects the cat flea will indirectly win again, as it has been doing, quietly, for years. ☐

The Health Education Council's film, "Start from scratch" can be hired free from the Central Film Library

Can Britain bridge the energy gap?

North Sea oil and gas will give Britain a short spell during which its energy production will more than match consumption. But there are questions as to how long this period of self-sufficiency will last

Michael Kenward

Behind the scenes disagreements on Britain's energy picture are coming into the open thanks partly to the National Energy Conference (NEC) that is being held at Energy Secretary Tony Benn's request. The NEC takes place next Tuesday with the Prime Minister opening the show and Benn in the chair. A key topic at the meeting, if the pre-conference papers are anything to go by, could be when an "energy gap" will hit the country as North Sea oil and gas begin to run out.

Britain now imports crude oil to make up the gap between indigenous energy production and energy demand. Oil started to flow ashore from the North Sea fields last year and by 1980 or soon after Britain's energy production should more than match consumption. The UK may even be an exporter of energy during the 1980s, but this state of affairs may not last very long. In the longer term, Britain will once again enter the world fuel markets as an importer. The answer to the question "when will this happen?" seems to depend on which energy industry you are a part of.

The coal industry has been in the forefront of the school of thought, which includes the majority of energy experts, that says there will be an energy gap in the 1990s; while the British Gas Corporation (BGC) maintains that there will be no energy deficit before the turn of the century. In its paper for the NEC, BGC, in a document whose expensive production could be counterproductive when set beside the other more modestly produced papers, warns against planning national policy on the assumption that there will be an energy gap in the 1990s. "In the view of British Gas, such an assumption is very much open to question: certainly we would all be most unwise to allow energy policy decisions which have to be taken over the next few years to be determined by such an uncertain premise."

Another paper for the NEC, prepared by the Cavendish Laboratory Energy Research Group looks at various energy scenarios to the year 2000. The report's projections "indicate a rapid transition in the UK from an energy export potential in 1990 to an energy import situation in 2000. This transition is expected to take place against a world background in which energy supplies are increasing too slowly to match the earlier trends in demand."

British Gas says "adjustments to the high cost of energy is likely to reduce demand for primary energy by 85 to 135 mtce by the end of the century. Any shortfall in indigenous supplies will therefore be significantly less than is suggested by the projections of past trends". More oil should be found which will help maintain production in the 1990s, says BGC, and "it is not unrealistic to suggest that, allowing for further discoveries, production could remain above 170 mtce, so that Britain could well remain self-sufficient, or even a net exporter". (Oil production of 100 million tons a year is 170 million tons coal equivalent.)

There is, therefore, a good 10-year gap between the energy pessimists and the optimists as to when they expect Britain's energy gap to creep up on us.

No one can forecast with any certainty how much oil and gas will be found around Britain's shores; but it should be possible to calculate the sensitivity of the various energy indicators, such as the timing of the energy gap, to the amount of oil and gas added to known reserves. But even that would be just another number to argue about; just as people are now arguing about the energy gap and whether the UK's recoverable offshore oil reserves will be 3000, 4000, or 4500 million tons.

The important issue is not when the energy gap will hit Britain, but how to guide the nation's energy policy. As far as research is concerned, as the recent R&D report said, we have to assume the worst because if we take an optimistic line we will close off some technical options. But British Gas has little to gain by assuming that there will be an early energy gap, as the other energy industries are urging the Government to bridge the gap by controlling gas consumption in some way. BGC dismisses the notion of a 1990s energy gap and says: "There is therefore no justification for taking decisions on gas depletion that would be highly uneconomic and would place an unnecessary and heavy burden on gas and consumers." The other side of the picture is painted in a paper from the Nuclear Power Company Ltd. This says: "If, as seems likely, a transition from natural gas to substitute natural gas is required, the pricing of the natural material should increasingly take account of the long run cost of the substitute material so as to avoid the development of an industrial and domestic structure which cannot be sustained." Hence the calls, from various sources, for a tax on gas to bring it in line with other energy prices.

Keeping the options open

Would it be unwise, as BGC says, to plan Britain's energy policy on the basis of an energy gap in the 1990s? BGC warns: "Since present projections could be wildly wrong, we should avoid firm commitment to a particular course until lead times make it necessary, while concentrating on research and development work, to make a wide choice of alternatives technologically realistic." The counter argument could be that continuing to supply gas at a price substantially below the prices of other fuels could stifle some technological alternatives—for example, by reducing the coal industry to such a level that it cannot recover easily when called to fill the energy gap whenever it occurs. And nuclear industry lead times, for example, are such that the industry could be hard pressed if it has to embark on the construction of breeder reactors to meet an energy gap after the turn of the century, let alone in the 1990s.

An even more unwise course than interfering with the gas industry could be to plan Britain's energy future on the basis of oil and gas reserves that have yet to be found. If Britain proceeds on the assumption that there could be an energy gap in the 1990s, then it can build up conservation experience and the energy technologies that would ensure that there is no energy gap. By saying that it thinks the UK will be well placed in the 1990s, the government could diminish the incentive to save energy. There is, therefore, a basic dilemma—assume there will be an early energy gap, act accordingly, and the early gap will not happen; assume there will not be an early energy gap, do nothing, and the gap could be with us before anticipated.

If the government works on the assumption that there will be no early energy gap and it is wrong, then the impact on the country and its industry could be devastating, with desperate energy shortages hitting Britain just when world prices could be rising. But if it assumes that there will be an energy gap and is wrong, then the country will have broader options than anticipated. Perhaps the NEC should address itself to this choice, rather than to a choice of which theory it will accept on the energy gap and its timing. □

Monitor

Sagan expects life to loom large on Mars

"Large organisms, possibly detectable by the Viking lander cameras, are not only possible on Mars; they may be favoured." So say Cornell University planetary scientist Carl Sagan and Stanford University Medical School geneticist Joshua Lederberg in a special eve-of-Viking issue of *Icarus* (vol 28, p 291). They draw this conclusion from some daring speculations about possible Martian life.

While the reconnaissance probe Mariner 9 in 1971-2 put some constraints on possible Martian biology (no gangs of Martian navvies digging canals, for instance) its photographs of Martian volcanoes and apparent dried-up river valleys suggested that conditions in the post could have been suitable for life, even if the climate is now hostile.

In a spirit of "seeking possible alternative ecological niches", Sagan and Lederberg identify in their paper four classes of conceivable Martian organisms, associated with different temperature and water requirements. Class I organisms, liking warmth and moisture, correspond to Earth-type organisms, and it is towards these that the Viking biology experiments are slanted. Such organisms might exist today in restricted areas on Mars where geothermal heat melts the anticipated subsurface permafrost.

But Sagan and Lederberg also consider the possibility of more widespread organisms that extract their water requirements from hydrated minerals or even ice. They term these lifeforms petrophages (rock eaters) and crystophages (frost eaters). Even a thin nightly frost might support a cover of moss or lichen over many parts of the Martian surface.

These would belong to Sagan and Lederberg's Class-IV of Martian organisms, the most exotic of all, able to survive in environments of low temperature and little water. (Classes II and III would be intermediate types.) "Class IV organisms would have to heat themselves metabolically as well as employ metabolic energy to extract moisture from surface minerals or ice," they note. Such metabolic heating can best be maintained in larger organisms, because of their smaller surface area relative to their volume; therefore, Sagan and Lederberg argue that large organisms will have a selective advantage on Mars. "The widespread impression that if there is life on Mars it must be confined to micro-organisms is a misunderstanding," they state.

Such large organisms could be detected by the Viking television cameras, even if their body chemistry defeated the biology experiments. To ward off ultraviolet light, they might carry shields around with them, like the exoskeletons of shellfish and insects; the shells of dead organisms, or their fossils, could be visible to cameras even if life itself has died out.

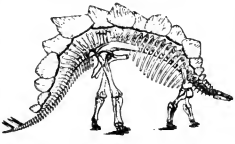
Sagan and Lederberg conclude that, while Viking 1976 represents a significant first step in the *in situ* search for Martian biology, negative results would exclude only a subset of possible Martian organisms. They therefore recommend a wider spectrum of biological experiments for future probes.

But they are not totally pessimistic about the chances of the current Viking biology experiments. Even if Class I (Earth-like) organisms exist only in selected habitats on Mars, the high Martian winds will probably blow their spores or pollen all over the planet so that Viking, no matter where it touches down, stands a good chance of raking some of them in. And Chryse, the first Viking's prime landing site where it will touch down at 0141 hrs GMT on 5 July, seems as good a place for them to flourish as any. ☐

Civil engineering gives dinosaurs a thermostat

Stegosaurus, one of the more bizarre of the family of dinosaurs, sports two rows of fins running from the top of its neck to almost the tip of its tail, a distance of almost 25 feet. According to three American researchers at Yale these structures are not designed to impress potential mates or protect against the aggressive attentions of other dinosaurs, as has sometimes been suggested. Instead, they are a central cooling system.

For many years the dinosaurs, which thrived between 225 and 75 million years ago, have been variously held in awe because of their impressive and bizarre physical form, held to ridicule because their great lumbering bodies housed only a miniscule brain, and puzzled over because of the unnatural haste with which they became extinct.



skeleton showing bony fins

Whatever else is true of our view of these fascinating creatures, it is certain that we have underestimated them, not to say slandered. There is an increasing body of evidence suggesting that the dinosaurs were both more nimble than we have given them credit for, and that, instead of being totally passive reptiles at the mercy of changing external temperatures, they could regulate their body heat almost as efficiently as the early mammals. The report by the Yale researchers (*Science*, vol 192, p 1123) supports this view.

James Farlow, Carl Thompson, and Daniel Rosner examined the civil engineering specifications of the *Stegosaurus* fins and find them ideally arranged to induce maximum air flow around them. The double row of staggered fins with the largest at the highest point of the back arch contributes to efficiency of "forced convection".

The second aspect of the cooling system is of course something from which heat can be lost, and this is almost certainly blood. The fins are made of bone, but morphological and X-ray studies suggest that there were channels inside the bone and on its surface through which blood might have circulated. It seems reasonable to assume that the animal could regulate the volume of blood flowing through the fin according to the degree of heat-loss required.

The Yale team suggests that, although *Stegosaurus* can disperse slightly more heat by facing the wind rather than being side on, it is much less dependent on a good orientation for heat-loss than is a finless animal. ☐

Liquid helium spins two-by-two

Rotons, little quantised vortices of rotating superfluid helium, appear to be created in pairs. At least they are made that way in the wake of a charged particle—an ion—when it is dragged through the helium at high speed.

The simple roton pairing effect went entirely unpredicted and remains unexplained. Its discoverers, Drs D. R. Allum, R. M. Bowley, and P. V. E. McClintock of the University of Lancaster, write in their paper that "No feature of our present, admittedly rather vague, physical picture of the roton has enabled us, even in retrospect, to account for the existence of selection rules which apparently favour roton creation in pairs but forbid their emission singly or in other combinations." (*Physical Review Letters*, vol 36, p 1313).

The rotons are created in the wake of a charged particle when the particle's speed is greater than the Landau critical velocity. At this velocity, in the absence of rotons, the superfluidity of a superfluid should break down. Phillips and McClintock were the first to demonstrate—about two years ago—that speeds in excess of the critical velocity could be achieved, and their further work has measured precisely how the excess velocity varies with increasing force on the ion.

The measured variation—with the cube root of the force—fits calculations assuming that the resistance experienced by the ion is caused by the paired emission of rotons. On energy grounds single rotons would be favoured. ☐

Keep your cool and win the race

In a few months' time, international athletes will once again run one of the most gruelling tests of endurance, the Olympic Marathon. Erika Baum, Kurt Bruck and Heinz Schwennicke have recently reported one of the physiological adaptations which seems to be essential to long distance runners, and which is acquired by them in normal training.

Seven marathon runners were compared with averagely fit (or rather unfit!) volunteers in their responses to extremes of temperature. The variables under study were the onset of sweating and shivering at the temperature extremes; both occurred at lower temperatures in the athletes. This seemed to indicate a shift downwards of the "set point" of the body thermostat. When the resting body temperatures of the subjects were measured, the runners did in fact show lower standard temperatures.

The difference is only about half a degree centigrade, at most, and this may not seem like a potentially race-winning difference. However, overheating is one of the main physical limits to endurance, and at a certain critical temperature, a runner simply stops, whether he wants to or not. A calculation on the energy budgets of men pushing the limits of endurance as hard as they can shows that a lower standard body temperature of only a tenth of a degree below "normal" will put off this point of total exhaustion by six minutes, and, as witnessed by some of the more dramatic and heart-rending last laps of the Olympic stadium, six minutes can mean an awful lot to a marathon runner.

Theoretically of course, the decrease in shivering threshold would allow an athlete to cool his body temperature even more by taking a cool bath before the race. However, the athletes insistence on "warming up" before a race seems to rule this out as a practicality, and we probably won't see the athletes emerging from a row of cool baths before the marathon in Montreal. ☐

Important 'human' fossil found in Greece

Petralona, a small village in northern Greece, is the site of the oldest fossilised bones of ancient "humans" so far discovered in Europe. Anthropologist Aris Poulianos has just found parts of the skull cap and one vertebra of a human ancestor who lived possibly as long ago as half a million years. Poulianos is currently extending the excavations in the hope of finding more fragments of the skeleton.

The excavation site at Petralona is in an extensive system of caves which were discovered by villagers in 1959. Since then the site has become one of the most important of its kind in Europe, with discoveries of animal bones, pre-human skulls, and stone tools. Although exact dating of the site is difficult by the reliable geophysical techniques archeologists like to rely upon, the selection of animal remains implies an age of around 400 000 to 500 000 years. Poulianos says that the most recent find is in the older part of the deposits; current tests on associated minerals should soon clear up this element of doubt.

The first skull found in the caves, in 1960, was initially said to be a type of Neanderthal Man, a cousin of Modern Man who lived in the colder parts of Europe around 100 000 years ago. It soon became clear, however, that the skull was much more primitive than this, and had many similarities with the *Homo erectus*, the form of hominid that came directly before *Homo sapiens*. The 1960 skull is probably around 400 000 years old and is the most complete specimen of its age. It might represent the very borderline between *erectus* and *sapiens*. The most recent find may turn out to be slightly more primitive.

This latest find is particularly important because of the uncertainty about the date of the transition into *Homo sapiens*. The latest refinements which produced modern humans, *Homo sapiens sapiens*, occurred about 40 000 years ago. ☐

SPEAR confirms charm discovery

The discovery of "nakedly" charmed particles, reported exclusively in *New Scientist* four weeks ago (20 May, p 413) has now been officially announced by the physicists concerned—a large group from the Lawrence Berkeley Laboratory and the Stanford Linear Accelerator Center, working at the SPEAR machine for colliding-electrons with positrons.

The group attribute the immediate impulse for the discovery to two men—Gerson Goldhaber and Francis Pierre. Goldhaber, a professor of physics at the University of California, and Pierre, on leave from the French particle physics centre at Saclay, were working on an improved technique for detecting charm decays, and managed to gather together about 100 candidates for the decay of a charmed particle. Then they called in the rest of the group, who helped to confirm the observation and establish the particle's properties.

The significance of the discovery is that it will be taken to establish—after nearly two years of fervent expectation—that there truly is a fourth kind of quark in nature: the charm quark. The fundamental building blocks of matter are the "up" and "down" quarks (which sit like plums in plum puddings in protons and neutrons, the components of atomic nuclei) and leptons (electrons and neutrinos); so the discovery of an extra building block to add to these few is exciting.

The last time a new quark was discovered—though it wasn't recognised as such at the time — was in the 1950s, which turned up the "strange" quark. ☐

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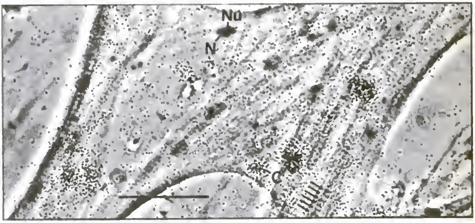
AIR CANADA

Dynamic relationship between nerves and muscles

The junction between nerves and muscles has a collection of molecular receptors for the chemical neurotransmitter, acetylcholine. Biologists are trying to discover what part these clusters play in the location of the junction



Myotubes with labelled bungarotoxin. The clusters of acetylcholine receptors are denote C. N: nucleus; Nu: nucleoli; the line represents 50 μm

The relationship between a voluntary muscle and its innervating nerve is not only functional—the nerve signals the muscle to contract—but also structural: it is the activity of the nerve that dictates precisely what contractile proteins the muscle shall make (fast or slow) and where it shall put the receptors that enable it to pick up the neural signal.

The signal, for vertebrate voluntary muscle, is acetylcholine; and the acetylcholine receptors are clustered at the junction of the nerve with the muscle. The appearance of those receptors during development, and their distribution at various stages and in various conditions, have been the subject of an increasing amount of research aimed at discovering how the vital relationship between muscles and their nerves comes into being.

The reason for the interest is twofold: it may shed some light on what goes wrong in diseases such as muscular dystrophy, where it seems that the relationship breaks down; and it is the most accessible system for looking at the important general question of nerves contact their targets during embryonic development.

Adult muscle is very dependent on the nerve that innervates it, and if the nerve is removed the muscle dwindles and acetylcholine receptors appear indiscriminately all over its surface membrane. Embryonic muscle, however, is much more independent.

One of the main unresolved issues in the neuromuscular field is whether it is the nerve or the muscle that takes the initiative in forming the relationship. Joav Prives, Israel Silman and Avraham Amsterdam at the Weizmann Institute are among the most recent researchers to try to pave a way to answering that question, and they have started by seeing how far embryonic muscle cells can control the distribution of their own receptors when they are grown in culture in the total absence of neural influence (*Cell*, vol 7, p 543).

Prives and his colleagues used chick muscle, removed from the chick before the cells have fused to form myotubes (one of the early steps in muscle differenciation and morphogenesis). They picked out the receptors by the use of radiolabelled snake venom—alpha bungarotoxin, which poisons the snake's victims by blocking the acetylcholine receptors of the animal and thus paralysing it, and which is extensively used by physiologists precisely because of this ability to bind to the muscle receptors.

By tracing the distribution of the labelled toxin, they were able to follow the appearance and movements of the receptors in the cultured muscle cells. What they saw was as follows. When the receptors first appeared (a few hours after the fusion of the cells into myotubes), they were seen all over the muscle cell surface. After seven days, however, the receptors to be found only in small clusters and their overall numbers had greatly decreased. By the 10th day, the clusters had vanished.

What has this sequence to do with the formation of nerve-muscle junctions that would accompany it in the living animal? One possibility is that the receptor clusters are the muscle's way of beckoning the nerve to make a connection—that it is the muscle that first sets the relationship with the nerve. But in the adult it seems to be the other way round: where you put the nerve (for you can move it around) decides where you get the receptor concentration. Not only that, but there is a good deal of evidence that the receptors at the junction are chemically different from those that appear all over the muscle surface when the nerve is removed. Were the Weizmann group's receptors junctional or extrajunctional ones?

Clusters to be swallowed?

One possibility, suggested by Prives and his colleagues, is that the aggregation of the receptors into clusters may have been no more than a preliminary to the cell's swallowing them up—and hence the decrease and eventual disappearance of the receptors from the cell surface. (That may seem a strange suggestion, but such behaviour on the part of cells is not unknown in other circumstances.)

On the other hand, the clustering of the acetylcholine receptors coincide with the spontaneous appearance of electrical activity in the cultured cells. And that could be significant, because it is by causing electrical activity in the cells that the nerves exert their influence. All the changes in the muscle that follow removal of the nerve can be prevented if the nerve is kept electrically stimulated by means of a small electrode. Extrajunctional receptors do not appear, and the junctional ones stay put.

And that leads to another question: what exactly is it that is influenced by electrical activity in the muscle? Patrick Hogan and his colleagues at Harvard have taken a first step towards answering that question by establishing one thing that definitely is not (*Nature*, vol 261, p 328). They cut the nerves to one half of the diaphragm of adult rats, removed the diaphragm five days later and cultivated it under electrical stimulation. To trace the distribution of acetylcholine receptors, they used the same labelled alpha-bungarotoxin trick that Prives and his co-workers exploited.

By the time the muscles were taken out of the rats, extrajunctional receptors had already developed as a result of the nerve's having been cut. But the electrical stimulation resulted in the reduction of those receptors again. What Hogan wanted to know was whether that happened because receptors are degraded more rapidly under stimulation. However, when he compared stimulated and unstimulated muscle, he found that in fact, degradation takes place more rapidly in the absence of stimulation. Hogan and his colleagues conclude that the change must result from changes in the rate of synthesis instead.

But before neurobiologists plunge any more deeply into the mechanisms triggered or halted by the activation of muscles, they have still to knit together their ideas about what is going on at their surface. What, for instance, is the relationship between the phenomena they have described in culture and what goes on in the live animal? How different are embryo and adult? What is the mechanism and the function of receptor clustering in and out of culture, and in the embryo and adult muscle cells? Some of those questions are already accessible to direct investigation.

Miranda Robertson

Technology

Sunny Brighton played host last week to the Communications 76 exhibition and conference. Our computer correspondent, Hedley Voysey, reports on a "bike-in-the-shed" computer terminal, and Duncan Campbell probes the military connection

Updating the electronic eavesdropper

A wide range of systems for monitoring and recording radio communications was a distinct feature of the Brighton show. One of the most sophisticated and costly computer-based systems, called Ceres, was unveiled by Redifon Telecommunications. Ceres uses a small computer to provide remote control scanning and recording of up to several dozen receivers; reducing, it is claimed, the amount of skilled manpower necessary in this highly specialised clandestine field.

The Computer Enhanced Radio Emission Surveillance System was developed under a contract placed four years ago by an unspecified British government department. Government Communications Headquarters (GCHQ), a section of the Foreign Office, is known to be involved in running a world-wide network of electronic listening posts. The need for a new computer-based system is reportedly related to a shortage of radio operators, as many of those recruited during and after the last war reach retiring age.

Each Ceres console, of which a dozen have been initially ordered by the government, provides manual and computer control of four radio receivers at present covering the high frequency radio band. The receiver may scan continuously a particular part of the spectrum for activity or maintain watch on a set of discrete channels. Another technique, more useful in overt activity such as recording news broadcasts and press agency dispatches, is the facility to preprogramme the times of monitoring each channel. A typical monitoring installation would include six such consoles and a supervisor's position for assigning priorities.

Associated with the receiver complex is a purpose designed tape recorder called Keepnet, which records up to 64 minutes of monitoring on each of four channels, enabling the capture of short signals and their later transcription at a time of little activity. The tape loop is held in a "scramble bin" and can be scanned at very high speed, stopping when activity is found on a particular channel. The Keepnet equipment was developed by Racal for a similarly unspecified government department.

Redifon's Ceres and similar systems are designed for use with remotely tuned and controlled radio receivers which can, if necessary, be connected over telephone lines. A particular advantage of computer-controlled systems can be for locating the position of clandestine or hostile radio transmitters.

Location is done by direction finding (DF). Normally a series of DF stations have to be contacted manually and given information on the signal before measuring bearings, with considerable risk of loss of a short duration signal. With a computer-based system, the data network linking monitoring radio stations may be used to transfer the request for a "fix" rapidly, and automatically.

Although the Ceres equipment is expensive, costing from £200 000 to £1 million for a single monitoring site, Redifon hopes for considerable export success. It is rapidly becoming unfashionable for Middle Eastern and African countries not to be equipped with such electronic surveillance systems. As well as military users, an Arab news agency is considering using Ceres for pre-programmed reception of news broadcasts. ☐

Plessey unwraps the army's STD

The results of a £30 million effort extending back almost 20 years to develop a versatile automatic battlefield telephone system were displayed for the first time at Brighton. Ptarmigan, developed by Plessey, will be in operation in the early 1980s, providing the army and RAF in Germany with a versatile trunk telephone system which is widely dispersed and highly mobile.

The development of Ptarmigan, according to Brigadier J. Akass in a paper given at the parallel Institution of Electrical Engineers conference, goes back to a joint Australian, Canadian, US and British proposal in the 1950s called Hobart, which later evolved into a specific proposal for a similar point system to be called Mallard. Mallard was sunk in 1969 for internal political reasons in the United States, and as a result Britain proceeded on its own with Ptarmigan. France, Germany and the US all have similar, but not entirely compatible, systems currently under development.

At the heart of the Ptarmigan network are some 20 electronic stored program control telephone exchanges using digital switching. Each exchange is mounted in a single truck, and moves around with a group of six or seven associated radio relay trucks. Each of these may provide a multichannel link to another trunk node or switch, or single channel radio access to individual Ptarmigan "subscribers" via secure encoded radio links. Since all transmission inside the system is digital, encyphering signals electronically is relatively easy and is done directly by a purpose-built integrated circuit built into each subscriber terminal.

Each subscriber has a unique and unvarying telephone number which directly corresponds to his division and status in the military hierarchy. The system is designed so that any arrangement of subscribers and switches is allowable, with a high degree of interconnection to render the system comparatively invulnerable to damage or failure. When a number is dialled, a search is instigated which finds the parent switch responsible for that subscriber. The call is then set up, and the route remembered if the subscriber is called frequently.

Each communications centre is designed to be highly mobile, and may move position every two hours, depending on the "set up and tear down" time.

An important concept is the wide dispersion of all the component parts, which together with fluidity of operation makes Ptarmigan resistant to damage; there will generally be at least two paths to any subscriber. As well as being intelligent in comparison with the civil trunk network, it will also provide subscribers with push button dialling, conference and broadcast calls, priority calling and data, telegraph, or facsimile transmission. ☐

A 'bike-in-the-shed' computer terminal

Pilot production will start before the end of this year of a new computer terminal type. Intended to be sold at a price of around £350 and used as casually as the proverbial "bike in the shed", the unit comes from the Aycliffe plant of GEC Telecommunications.

The designers of the new terminal presented the design at last week's Communications 76 conference in Brighton. They have stressed rugged and simple mechanical parts. Ruggedness in computer terminals is associated with affluent military computing projects; but the division at Aycliffe designing the new Datacom 10 and 15 units is engaged in producing telephone subscribers equipment which has to survive the hazards of domestic and office environments.

Most cheap computer terminals have centred on a cathode ray tube display, rather than printed "hard copy". The Datacom unit however, prints out on an inch-wide strip of paper using a printer designed for the job and adds a full data entry keyboard to form a basic Datacom 15 unit. This is the one that is due to be tried in the field soon.

The more elaborate Datacom 10 has a built-in modem operating at up to 300 bits per second and a 10-key push button telephone—this links the terminal to the telephone system. However, this unit needs full Post Office approval before production—so the simpler Datacom 15 can be attached to existing equipment that links to the telephone network, and is the first into production.

Combining this simple terminal with public information retrieval services, such as envisaged by Viewdata (through the PO), or Euronet (through the EEC) should make these computer based services more attractive. Potential markets also encompass PO counter staff and general retailing where a terminal to each position demands cheap units. ☐

Changing environment for R & D

The rapidly rising R & D budget of the Department of the Environment (DoE) is threatened by Britain's current financial problems. The third DoE annual report on R & D shows that the budget rose from £26·8 million during 1974-75 to an estimated £34·7 million for 1975-76. According to the report: "The programme planned for 1976-77 will be closely comparable in size to that for 1975-76, but plans for work in later years are currently under rigorous review in the light of present economic and financial factors."

The effects of the "customer/contractor" relationship continue to spread through the R & D programme. Three of the four cooperative industrial Research Associations (RAs) receiving money from DoE receive a "general purpose" grant, which is gradually being reduced "to make . . . grant support increasingly selective, in accordance with the customer/contractor principle, to help an RA establish itself in a new area where its intervention is judged to be desirable."

Over £600 000 is now paid to the RAs by DoE as "grant and quasi-membership payment" out of a total departmental spending on RAs of just under £3 million.

While the aim is to have the customer/contractor relationship spread throughout the DoE's R & D work, the Department's Director General of Research can support work that is "either exploratory in character, for example, state-of the-art reviews of areas of potential Departmental interest, or of a speculative and high risk nature, to develop a new understanding or methodology". During 1974-75 the Department funded three projects in this way, amounting to 0·1 per cent of the planned programme.

The "discretionary" projects covered telecommunications, bus services, and "environmental dissatisfaction". The growing use of telecommunications "may have significant impacts on the future location of work places, and on business and travel-to-work patterns", which clearly brings the subject into the DoE's area. There could also be increasing domestic use of telecommunications facilities such as "remote facilities for shopping, banking, and education". The DoE has established an exploratory research programme "to identify the broad impacts of these developments".

The other projects include a small study 'to investigate the scope for utilising the off-peak capacity of bus services to assist with the distribution of suitable freight". The third project "is a speculative approach to the difficult methodological problem of devising a general index of environmental dissatisfaction that encompasses varying combinations of noise and visual intrusion". The Transport and Road Research Laboratory has built a simulation laboratory that "enables traffic scenes and noise to be projected to what is apparently an ordinary living room. This provides a facility for controlled experiments to assess the values that people place on disturbances in their home environment from road construction and traffic. ☐

Department of the Environment Report on Research and Development 1975, available from HM Stationery Office, price 95p.

Satellites in a spin

A mechanism to stop geostationary satellites "wobbling" in their orbits has been invented by BAC space engineer Steve Tonkin. The small and simple flywheel device is said to be the answer to problems encountered in the launch of cylindrical satellites.

The problem is that cylindrical vessels are not naturally stable in orbit. A flat, disc shape would behave very much better; but the design of a satellite is largely dictated by that of the launch rocket; long and thin. The wobble, or nutation, of the orbiting cylindrical vessel must therefore be compensated.

Previous control methods have been complex and energy consuming, increasing weight and cost. The proposed new style of nutation damper is small and light, uses little power, and is inexpensive. The device consists of a "compliant" flywheel, which could be a canister of fluid, spun in the direction opposite to the spin of the spacecraft. The flywheel is mounted on a spherical bearing, and its function is to dissipate the energy of nutation and so prevent wobble building up to an unacceptable degree. Requiring only a few watts of power to drive the motor at a non-critical speed, the device is quite small, needs no independent control system and can be fitted anywhere within the spacecraft.

The device which was described by Tonkin at a recent conference of the International Federation for Automatic Control, held in Germany, has aroused a great deal of international interest. Attendees from the European Space Agency, Russia, China, and the US were optimistic for the prospects of the device, according to Tonkin. A design for a skylark rocket payload is underway.

The first application of the device will be in geostationary communications satellites, according to the inventor. One such satellite which may well benefit from the inclusion of the new stability mechanism is OTS, the European experimental communications satellite. ☐

Five more Czech years

Czechoslovakia's current five-year plan (1976-80) calls for the country to spend almost 3·8 per cent of its gross national product of £2000 million a year on research and development. The plan emphasises the rationalisation of raw materials and energy consumption, with R & D focusing on mining technology and the design and development of energy equipment. The research programme will employ about 2·1 per cent of Czechoslovakia's work force. ☐

New round of Wankel troubles

The troubled Wankel rotary internal combustion engine saw another setback last week when General Motors announced that it would defer future payments of world-wide licensing rights. According to a report in *The New York Times*, GM has already paid $38 million for the rights to the engine, but the latest move may mean that GM never puts the engine into production. Poor fuel economy and high exhaust emissions made GM rethink its plans to introduce a Wankel powered vehicle two years ago. GM's licence is with Audi-NSU and Wankel. Over the years various licence deals have been arranged between the companies, but GM has yet to decide on full-scale production. The report in *The New York Times* says that some observers put GM's expenditure on the Wankel engine above $200 million. ☐

Rover cuts down on cuts

The Rover 3500 (with its justly deserved reputation for safety innovation) is the first production car to be fitted with a new Triplex laminated windscreen. The windscreen—known as Ten Twenty—"virtually eliminates severe cuts to the face and severe injuries to the eyes", according to Triplex. In essence, the windscreen is [illegible] with a plastic lining. When the inner, mobile [illegible] is hit by a head it breaks down into small granules with blunt edges, which remain bonded to the plastic lining. The plastic also cushions the head [illegible] the windscreen. In an [illegible] the outer glass cracks [illegible] small [illegible] does not shatter and so retains visibility. ☐

IBM's new image is all PIE in the eye

The ever prolific research laboratories of International Business Machine Corporation — IBM to you — reports the discovery of "a new approach to recording light images". Instead of using the chemically triggered and irreversible processes that are the basis of photography, IBM's process triggers the development of a latent image by switching on an electric field.

The new image recording process is based on an electrochemical phenomenon called "photoinduced electrochromism" (PIE). IBM's scientists observed this phenomenon in a transparent liquid film containing organic molecules of a class known as pyrazoline. They found that by exposing the liquid to a laser beam they could produce a faint blue-green image that was darkened by turning on an electric field to "develop" the image.

The field was switched on by applying a direct current across an experimental PIE cell. The coloured area in the cell darkened by an amount proportional to the applied voltage, and how long it was applied. The developed image was still visible several minutes after the voltage was switched off.

The "image" stays in the solution even after the electric field is removed. But the coloration can be "erased" by reversing the field. The solution is then ready for reuse. IBM's experimental PIE cell worked for dozens of exposures before degradation made it useless.

The image formed in the IBM experiments was a 2-inch by 2-inch line pattern commonly used for testing the resolution and reproduction quality of photographic equipment. The pattern was formed by turning on and off a scanning laser beam at points corresponding to the beginning and ends of lines. IBM has achieved a resolution of about 300 lines per inch.

The energy density required to expose an image in a PIE cell is in the order of 10 microjoules per square centimetre—an amount comparable to that used in exposing a medium-speed photographic film. ☐

Jim'll plug it

Underwater electrical connecters are not the easiest things to make —for obvious reasons. Standard Telephones and Cables has recently proved a connector that can be plugged and unplugged underwater while live for use at depths of 1500 feet. The picture shows "Jim", DHB Construction's atmospheric diving suit, trying out the STC connector, which can be used in fresh, salt, muddy, sandy, and polluted waters. The water pressure at the connector's operational range goes up to 700 lb/sq. in ☐

Flywheel spins out car fuel

A gear box from the Harrier jump jet, an 80lb flywheel, and a "car calculator" could save something like a third of the fuel consumed by a 2-litre engined car. It might cost you over £500 more for such a vehicle, but this extra capital outlay should be recovered after about 40 000 miles of motoring.

A Philips Industries research project at the Mullard Research Laboratories (MRL), Salfords, Surrey, has come up with a hybrid vehicle that offers these savings by running a vehicle with a flywheel system that allows a car's engine to operate at its optimum power level. No-one has actually built a vehicle based on the MRL concept, but Philips is talking to car makers about the idea.

In the flywheel assisted vehicle the car's engine would be linked to a flywheel, and there would be three operational modes for the vehicle; either running the car from the flywheel, the engine, or both. The engine runs the flywheel up to full speed—around 10 000 revs/min — and if the car is running slower than is most efficient for the engine, then the engine is turned off and the flywheel slows down, propelling the car as it does so. When the flywheel's speed falls below a certain level the engine is automatically turned on and the flywheel "recharged".

An important part of the system is a continuously variable gear box, and the Perbury device used as a part of the Harrier fits the bill. Another important component is the car calculator, a solid-state electronic device that would control the system—that is, tell the engine and the flywheel what to do and when to do it. The flywheel would be a "low technology" device—a mild steel disc 16 inches in diameter, $1^{3}{}_{8}$in thick, and weighing 80lbs.

MRL and Ricardo Consulting Engineers have studied the idea, and they conclude that a fuel saving of 38 per cent, compared with a manual transmission, is possible for a passenger car equivalent to a 2-litre vehicle. In fact, the flywheel assisted vehicle could have a smaller engine.

Philips is clearly interested in the car calculator and the electronics in the flywheel storage system. It will not take the concept any further without the support of a car company, and Philips is now talking to various European motor manufacturers. It would probably take something like three years to build the first prototype vehicle. ☐

Lighting the path to food freshness

Chemiluminescence is being studied by the Battelle Columbus Laboratories in Ohio as a possible "marker" for determining the freshness of food. Battelle says that present techniques for measuring the deterioration of food on the supermarket shelf are "time-consuming, expensive, and less than satisfactory". The laboratory has agreed a contract with five customer companies contributing $9000 each to develop techniques for using chemiluminescence as a measure of freshness. As food deteriorates, its unsaturated fats, oils, and other lipids emit light. Battelle researchers intend to use this phenomenon to assess freshness.

Dr Richard Nathan, head of the programme, suggests that such techniques could be useful for accurately determining the shelf life of products that might otherwise be prematurely withdrawn, for developing an indicator of the life of oil and therefore improving the flavour of food fried in the oil, and assessing the effectiveness of antioxidant additives. Initially, the programme will be for one year, but Battelle hopes that it will grow into a longer study. ☐

China boosts offshore oil and gas search

Marine geological explorers in China have completed a survey of the oil and gas deposits in the Pohai Bay area, along the upper northern coast. This is a significant achievement; China's exploration of her territorial waters and the development of a technical capability in this area is gathering momentum.

A recent report from *Hsinhua*, the official Chinese news agency, says that extraction has already begun on high-yielding oil wells discovered around Pohai Bay area. Up to now this has been the most explored area of the Chinese coast line, but within the past two years marine geological surveying has been extended to a number of islands and coastal areas in the Yellow Sea, East China Sea and South China Sea. The Marine Geological department has now obtained comprehensive surveys of seismological, magnetic and gravimetric conditions in these areas and work is underway on analysing samplings taken.

The Chinese Marine Project was envisaged quite early on but was badly affected in the early 1960s by the withdrawal of the Russians who took with them all the expertise and equipment on which the project was based. The Chinese began their own programme by converting wooden junks into ocean research vessels but suffered badly from a total lack of marine prospecting equipment. The first Chinese-designed and built floating drilling vessel named Kantan 1, was launched in 1974 and has been drilling for oil in the southern part of the Yellow Sea; it is reported to be capable of staying at sea for 160 days.

Kantan 1 is accompanied by several small research boats, including two purpose built vessels analysing the data from the drilling programme.

The Chinese claim that up to 100 factories around the country are involved in the project, turning out prospecting equipment and increasingly sophisticated research and drilling vessels.

Offshore oil and gas prospecting is likely to play an increasingly important role in China's search for energy resources, so that concentrated efforts can be expected. And this is one development in China's technology in which many western oil companies have a vested interest. Whatever the advances made by the Chinese themselves in developing better and better equipment, the gap between their present capability and that already developed by oil experts in Britain and US is likely to remain considerable for some time to come.

One major debate for the Chinese at the present time must be whether to pay the price for Western know-how or to continue along a line of complete self-sufficiency which may ultimately prove inadequate. Time is very important here as offshore exploration may eventually bring China and Japan into conflict over territorial claims. *Christine King*

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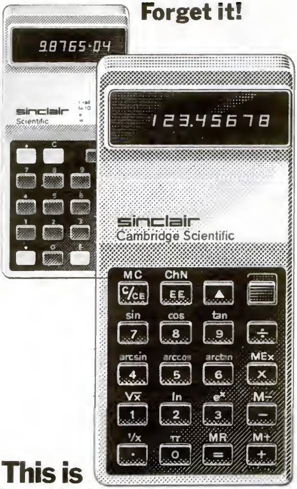

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Feedback

Will the EEC shift the milk mountain?

Britain is opposing EEC proposals to give skimmed milk from the Community's surplus to Third World countries. Put baldly, it looks bad. Milk mountains are an emotive issue in a hungry world. So with the EEC's larder brimming with over two million tons of dried skimmed milk (DSM), the suggestion that substantial quantities be donated to developing countries looks like good sense as well as good public relations—milk of human kindness and all that.

Is it though? The Dutch paper on which the aid proposal is based takes a view of world food problems which, after the complexities of the Rome World Food Conference, is almost nostalgic in its simplicity. Ten million people starve to death every year, it states. Skimmed milk offers an attractive source of protein. Protein deficiency is a component of starvation. So give the milk to the hungry.

The study estimates that aid agencies could channel over 300 000 tons annually to Third World countries. Private American organisations alone can, supposedly, dispose of 250 000 tons.

British objections stem from a somewhat deeper analysis. There are reservations about the chances of getting milk to the people who really need it. Food aid is always likely to disrupt local food production and produce long term dependency. But there is also some disquiet about the impact of massive milk distribution on public health and nutrition.

The change in infant feeding patterns in the Third World, particularly early weaning and the switch from breast to bottle feeding, has caused considerable concern. Attention has focused on the recent role of the multinational milk companies in promoting these trends. But there is good, if circumstantial, evidence to suggest that the disposal of DSM surpluses in the early 60s had a similar effect in many countries.

Britain is now offering a set of guidelines to govern any new distribution:

—Milk should not be distributed in a way which will permit or encourage it to be used as a breast milk substitute for infants.

—It should be regarded as a food rather than a milk, to be used as a supplement to solid food rather than reconstituted as a liquid.

—To avoid misuse, donors should monitor and evaluate the effectiveness of distribution and the pattern of consumption.

As originally conceived this would have stopped any massive give-away. Agreement has, however, been reached in Brussels for the supply of DSM to Bangladesh at marginal cost for retail sale. Authorities there say it will replace

Chinese look to mass involvement in science

Currently a mass scientific debate is going on in China. This is not unusual. Mass debates are the norm for practically all matters, public or private. However this criticism of "revisionist science" appears to be gathering momentum. "The crux of the current debate," remarked a leading member of the Chinese Academy of Sciences, "is whether to persevere in the Marxist-Leninist line and advance along the socialist road in developing science and technology or to follow the revisionist line and take the capitalist road."

The criticism levelled at conventional scientists is that they opposed the mass movement in scientific experimentation and attempted to switch the research work back onto the pre-cultural revolution, revisionist track of relying on only a few experts.

The Chinese quote ample examples of mass involvement producing successes where experts failed. Earthquake prediction has become a major preoccupation for many amateur seismologists working in the countryside who have better opportunity to observe changes in natural phenomena claimed by the Chinese to indicate impending earth tremors. Clearly mass involvement is also feasible in meteorological studies, now a Chinese priority to help farmers in pushing agriculture forward.

The Chinese "open door" system means opening up education at universities and research facilities to the broad masses of people. New enrolling students may be selected from among the soldiers, peasants, or cadres as well as from the young people of university age. The emphasis is on those who have served society in some capacity for at least several years. The qualification is correct political thought rather than academic prowess. The involvement of the masses in scientific research takes the form of joint projects with professional scientists and personnel working together, the combination of scientific experimentation with production, and the integration of theory with practice.

If these radical changes can be achieved with success, certainly the overall effect on the steady development of science and technology in China will be far less disruptive than that of the cultural revolution during which universities and research establishments virtually came to a full stop.

Looking at papers in scientific journals such as *Scientia Scinica*, however, it is clear that theoretical research, particularly in mathematics, is still being pursued in many quarters. The current mass debate and the push for "open door" reforms may be the stir-up which can be expected in China at 7-9 year intervals to keep the people on their toes and not to deviate from the party line proposals set up by Chairman Mao.

At the same time the ultimate aim of the Chinese has always been to keep abreast of world development in science. Much of the world's most prestigious research work bears no immediate practical use for society as a whole. How the Chinese aim to solve this dilemma of reconciling the two issues should be of great interest in the immediate years that lie ahead.

Christine King

Mike Kenward wins Glaxo award

New Scientist's technology editor, Mike Kenward, is one of the recipients of this year's Glaxo Travelling Fellowships for science writers. He plans to use the £700 award for travel in connection with a projected book on fusion research.

The four winners, who received their awards yesterday from Glaxo's chairman, Austin Bide, are: Tony Osman, *Sunday Times* magazine (national), Rodney Tibbs, *Cambridge Evening News* (regional), Edward Goldwyn, BBC-tv (broadcasting) and Kenward (trade and technical).

In summing up on behalf of the judges, Dr Martin Sherwood, chairman of the Association of British Science Writers which administers the award for Glaxo, said that it was only after lengthy discussion that Kenward's work on *Energy file* had been classified as "trade and technical" writing. "The move to consider entries from both *Nature* and *New Scientist* in the trade and technical category came from Nigel Calder, a former *New Scientist* editor, and one of this year's judges," he said. In previous years, *New Scientist* contributors had won awards in the national category, although these awards had been made before a trade and technical category was established.

The award, said Sherwood, had grown from two categories to four without serious consideration of the rationality of such growth. After three years as chairman of the judging panel, he felt that it was time to reappraise the award scheme. He added that he understood that Glaxo was also interested in rethinking the scheme. ☐

expensive commercial imports—they could have added that the revenue from sales of donated food is now an essential component of the government's income. The World Food Programme claims that no distribution difficulties or health hazards are likely to arise. Details for the supervision of what Britain has agreed as a pilot scheme are only now being negotiated.

The political priority of Europe's milk producers is to shift the burden of that milk mountain. But onto whose shoulders? Is the potentially valuable resource simply going to be squandered somewhere distant from Brussels?

There is a real need for DSM. Hospitals, nutrition rehabilitation centres, and other community organisations can use imported high protein foods. Their individual needs, however, are small. Distribution to this sector on a scale large enough to dent Europe's surplus would be difficult to organise. But if the EEC is really trying to aid the Third World—and not simply use it as a dustbin—then it must get its milk to those who need it. Meanwhile the British negotiators should hold out for a careful on the spot evaluation of the Bangladesh exercise. *Mike Muller*

Technology and the social wage

A demand for the production of socially useful products has been included with the annual wage claim by a major trade union. AUEW (TASS) included the demand last week in its claim for 4000 engineers, scientists, and technologists at Lucas Industries (including CAV, Girling, and Simms). The union was acting on the proposals contained in the alternate corporate plan prepared by the Lucas Aerospace Combine Shop Stewards Committee (See *New Scientist*, vol. 67 p. 10 and vol 70, p 339).

John Rowan, TASS National Organiser for Lucas Industries, told personnel director Brian Mason that as a result of government policy, both last year's wage settlement and the current £6 limit represented substantial wage cuts, while Lucas profits soared this year to a record half-yearly £21 million. Since the TUC-backed wage restraint was said to be in the national interest, he wanted to know how Lucas intended to use the unpaid wages to that end.

"How much are you prepared to spend on the design and development of alternative socially useful products which have already been proposed by some of our members?" he asked Mason.

This is the first time that any national trade union has made a specific interpretation of the vague concept of a "social wage". The introduction of major parts of the corporate plan would be a complex and lengthy piece of collective bargaining. However, there are modest interim steps that could be taken immediately. The Lucas unions are particularly appalled that at a time when some of their members are facing the prospect of redundancy, there is simultaneously an acute shortage of the kidney machines which they produce. They are now demanding that the production of these units be increased by 40 per cent at the Neasden plant. With optimistic forecasts by the Lucas Chairman, Sir Bernard Scott, that the second half profits will be as good if not better than the first half, the Company is likely to come under considerable pressure to display its social responsibility when it gives its reply to the union tomorrow (Friday).

Meanwhile, the alternative corporate plan is drawing increasing notice. The National Executive Committee of TASS has decided to set up a working party, including some of its MPs and the Lucas Combine, to consider how these ideas might be implemented more generally throughout other large companies. And in Sweden, workers at a major glass company have initiated a similar project (see p 621). □

Is fish-farming farming?

The prolonged war of attrition between fish farmers and government bureaucracy took a new twist last week in the House of Lords.

Lord Balerno, President of the Scottish fish farmers' association, managed to introduce a clause in which aquaculture is deemed agriculture into the Agriculture (Miscellaneous Provisions) Bill. He did so in the face of opposition from the government's spokesman, Lord Strabolgi, who was apparently prepared to allow aquaculture to remain neither fishing nor farming, nor in some interpretations even food production, at least for the time being.

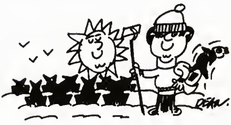
According to Lord Balerno, placing fish farming under the agricultural umbrella would do no more than is done elsewhere in Europe. In both Scotland and England the National Farmers' Unions have already accepted that fish farming is an integral part of agriculture. The Fish Farmers' Union of England and Wales merged with the NFU in June last year. The Scottish fish farmers have been a little slower to act; they do not care for the membership fee.

The fact that fish farmers have been slow to form representative groups has meant that skirmishes rather than battles have been the order of the day. For example, a trout farmer in Wales appealed successfully against his rating. He wanted to be treated in the favourable way enjoyed by traditional farmers. Despite the pleas of the Inland Revenue, the Land Tribunal took a "commonsense decision" in his favour. North of the border in Scotland, however, the Rating Act 1971 is still interpreted in a way that does not exempt the fish farmer from rating.

One of the objects of the Fish Farmers' Union in joining the NFU was to secure a clear statement from the government that fish farming is a type of farming and in all respects should be treated as agriculture in line with the EEC practices. Yet the action in the Lords saw them unprepared. In resisting Lord Balerno's desire to provide the fish farmer with an agricultural home, Lord Strabolgi drew strength from a failure of the representative organisations to comment on a recently circulated consultative document on fish farming in the UK. "The ball" he said "is in the court of the fish farming industry."

One justification put forward for the lack of official response to the document is that it does little more than reiterate the views of the industry that the law needs to be changed to protect what has become a growth area in food production. It contains nothing that has not been discussed, almost ad nauseam, at the conferences and seminars that have proliferated about fish farming and which have been attended by the civil servants most concerned with the problems of control and legislation for this fledgling industry. What the industry would like to see is draft legislation and a clear statement of what the government intends to do to promote UK fish farming.

The action of Lord Balerno and the inclusion of the clause has taken fish farming pressure groups by surprise. Certainly a great deal of toing and froing has been in evidence among the NFU fish farming interests and those in the Ministry of Agriculture, Fisheries and Food. Of course, if the tone of Lord Strabolgi's response is any guide to government opinion, the clause is likely to be struck out before the Bill is passed.



The interesting point is that this action within the Lords may have the salutary effect of bringing government and industry officials together. Fish farming in the UK cannot flourish in the present legal no-man's land. Perhaps the noble Lord Balerno was right to offer the amendment as a "holding operation, giving the Government time to get their own fish farming bill in order." Certainly, like him, many fish farmers "want to see the colour of their words."

"The fact that fish farms have quadrupled," said Lord Balerno, "is a sign of the ingenuity of the people who are fish farming, and it does not take account of those fish farmers who have gone bankrupt because of these contraints (legal and financial) and because of the bureaucracy attaching to it." □

Is Britain arming apartheid?

The admission last week that an £8 million communications system sold to South Africa is intended for use by the military in Namibia points to the need for a re-definition of "military" aid. But the South Africans are using high technology to make myths as much as to make war

Duncan Campbell
is a freelance journalist specialising in communications technology

In recent months anti-apartheid campaigners have discovered a clutch of South African orders for sophisticated military and communications equipment from Britain. In only one case, long-range communications equipment, has the Government made any effort to control the export of systems which fall within the domain of export control orders in accordance with UN sanctions. Gaps in export control range from the fact that sensitive equipment, which *would* need an export licence if ordered by European NATO countries, can be freely exported from Britain to South Africa, to the opportunities of sending goods via intermediate countries.

The £8 million contract with Marconi for the long-range communications system raised the problem of defining military sales. Marconi's claim that the system was "ordinary off-the-shelf" equipment fell on deaf ears, particularly when a young Marconi engineer (Jock Hall) announced that he believed the system to be destined for illegally occupied Namibia.

Now, another South African order for British communications equipment from Hasler (UK) Ltd has been similarly revealed by Bob Hughes, MP, Anti-Apartheid Movement vice-chairman. Prime Minister Callaghan has refused to block the sale of Hasler message switching equipment to the company's South African subsidiary for military use in southern Africa. Mr Callaghan claims. in a letter to Hughes. that such equipment could be "legitimately exported" to South Africa without a licence, while agreeing to investigate reports that the destination was Rhodesia.

The government did change the export control regulations in April so that Marconi now needs a licence for its £8 million order. This was widely interpreted as blocking the sale, but Marconi seems confident of obtaining a licence.

All communications systems are a vital part of the infrastructure of any military force. Indeed, the Marconi contract was placed by the South African Defence Department. Increasingly, sophisticated command, control, and communications (C-3) centres play a decisive role in the operations of most well-equipped forces. The South Africans have a modern C-3 centre at naval headquarters near Capetown.

Troposcatter communications

The Marconi communications system provides several long-range radio links, up to 800 kilometres, by bouncing microwave radio signals off the troposphere to a receiving station over the horizon. Four such links are specified in the Marconi contract, but the precise sites are confidential—again indicating the strategic nature of the system. The particular advantage of such "troposcatter" communications is that it can provide secure broadband radio links between a minimum number of sites without the risk of guerrilla attack on roadside cables or chains of closely-spaced microwave radio relays.

The South African contract specifies 27 metre antennae and high power amplifiers for the 900 MHz links. By referring to Marconi's own data, it is clear that at least two of the links will stretch troposcatter technology to its limit, to give a range of 800 km between stations. A number of shorter range "spurs" are also planned. These features of the contract indicated to the dissenting engineer, Jock Hall, that something other than an internal communications system was being planned. The Republic of South Africa already has an advanced national communications and telephone network, much of it equipped by Marconi's parent company, GEC. There seems little reason to use troposcatter—at full stretch—merely to supplement an existing adequate system.

But the Republic does have defence commitments to two less developed territories, Rhodesia and Namibia (South West Africa). Marconi refutes any suggestion that its equipment will be installed in Rhodesia. Last week at Communications '76 in Brighton, a Marconi spokesman officially admitted that the equipment was, indeed, intended for Namibia.

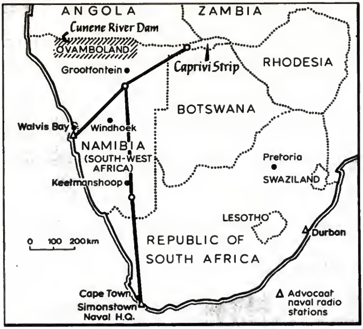
Namibia, a sparsely populated territory with an 85 per cent black population, has been occupied by South Africa since its capture from Germany during the First World War. The occupation, which was found to be illegal by the International Court of Justice in 1971, continues to guarantee the exploitation of the territories' considerable mineral wealth, and to provide a buffer state for the Republic itself.

Since the establishment of a hostile Angolan government, the threat to South Africa from the north has considerably increased, particularly through the densely populated but virtually undeveloped Ovamboland area. South African forces have established a number of major bases across the south of this area: from the naval and radio base in the Walvis Bay enclave, to a remote airbase at Katima Molilo in the Caprivi strip.

Troposcatter would provide a particularly reliable and secure method of controlling military operations from these sites. Two long range links, end to end, could span the 1500 kilometres to a command centre at Capetown. Alternative communications in Namibia—relying on buried roadside cables or large numbers of microwave radio stations—would be highly vulnerable to attack by Namibia's guerrilla forces. Conventional high frequency radio would be unreliable, insecure, and unable to handle large amounts of information.

The functions of the system, however, are unlikely to be spectacular, being largely related to the regular routine of the military occupation. ITT recently installed a similar military troposcatter command and control system throughout Spain—to "provide voice, data and teleprinter communications between military command and terminal sites. . . . . including technical facilities and remote supervisory alarms". It has been suggested that South Africa would use the Marconi troposcatter system to install a "fence" of remote sensors to monitor intrusions of guerrilla forces from the north. Such a system was attempted by the US forces in Vietnam, employing seismic, vibration, and ammonia detectors ("people sniffers") to gather data on supply movements that were then countered by remote controlled bombing attacks. However, warfare on the Vietnam scale is beyond the already overstretched South African forces, although localised electronic warning systems may be feasible. And the 1000 kilometre long Namibia border strip is quite unlike Vietnam's Ho Chi Minh supply trail.

The new system with main stations in or near well-held military areas would provide secure links to replace the vulnerable existing civil network. It would be a backbone carrying operational information, intelligence, command orders, material requests, and data—the normal work of such systems. Although the Marconi transmitter specified



Approximate disposition of Marconi's troposcatter equipment in Southern Africa. Triangles are Advocaat naval radio stations; circles are probably troposcatter bases (above)

Display in the Silvermine naval control centre near Cape Town (right)

in the contract can theoretically carry 330 radio channels, it is unlikely that relatively unsophisticated South African forces would need more than 60.

The troposcatter system would reportedly link to the Silvermine naval control centre near Cape Town. The Silvermine joint maritime headquarters is a glittering jewel of sophisticated C-3 with which the South Africans had hoped to lure NATO or the United States into a military compact for the southern oceans. In contrast to the secrecy surrounding the troposcatter system (and much other South African military procurement), the Advocaat control centre at Silvermine has been touted very publicly. When the original plans for the centre were formulated in the late 1960s, British companies (including Marconi) were to supply radio, communications, and computer equipment. But, during the last Labour government, the contract went instead to Telefunken of Germany.

A great deal of money was spent on the most sophisticated control and display equipment for the centre. Additional space was provided for "representatives of allied navies and air forces, if required". But none came. In 1974, South Africa placed a series of advertisements in British newspapers. One asked why NATO should not have a South African base at Simonstown, dangling as bait a "sophisticated communications surveillance system covering an area with a radius of 5000 sea miles".

The florid prose belied the actual nature of the Silvermine centre. Computer-generated displays at Silvermine show vessels on a plot extending from Brazil to the Indian Ocean—so large a scale as to be virtually useless for naval operations, but good for propaganda.

Any C-3 centre is dependent on the quality of the senses with which it can monitor its surroundings. Despite rumours of links to NATO or US spy satellites, most of Silvermine's information comes from two essentially public sources—an international merchant vessel registration network run by the US Coastguard, and the daily shipping register, *Lloyd's List*. Lloyds was "extremely surprised" to hear that its bulletins were being fed into South African computers, and said it could not prevent this happening.

The US Coastguard runs the Automated Merchant Vessel Emergency Rescue network (AMVER), which keeps computer track of some 14 000 ships all over the world. Information on the planned course of every ship which uses the scheme is sent to AMVER in New York via a chain of radio stations, including the Cape radio station at Silvermine. This information is processed to predict the vessel's future location on a computer display in New York. If an emergency occurs, AMVER controllers call up the predicted locations of any "subscribing" ships in the area and direct calls for assistance.

US data for SA computer

AMVER states that the South Africans are only responsible for relaying radio messages. But the programming of the Silvermine computers is in many ways identical to those in New York. It is apparent that any AMVER data obtained by South Africa can be fed into their own computers.

Both systems predict the track of ships from published information on planned courses. That data displayed on the screens at Silvermine comes from *Lloyd's List* is evidenced by the fact that "name, speed, shipping lane, cargo and course of a vessel" are all shown. Some of this information could not be obtained by inspection of vessels, even if South Africa had the equipment to carry out the inspection. The only other information input, according to South African naval spokesmen, comes from maritime patrols by ships and aircraft. But these inputs are quite inadequate (only two of South Africa's eight major vessels were built after 1945) to cover nearly 5000 kilometres of coastline.

The only other source of data on ship movements, hinted at in the South African advertising, is communications monitoring and direction finding equipment that receive signals over quite large distances. Two stations could provide a crude fix on maritime transmitters—and naval sources suggest that two such stations have been installed at Silvermine itself and near East London. These, however, would be unlikely to capture the very high speed "burst" transmissions of the Soviet Navy. Most of the easily monitored signals come from commercial shipping—a check on the Silvermine plot, but of little military value.

Nevertheless, no expense was spared to advertise the centre and the South African posture of protecting the sea routes for an ungrateful western alliance.

Despite apparent disinterest in South Africa's desperate efforts to win allies, reports of links from Silvermine to various military commands, including Whitehall, persist. But this is, again, South African propaganda to which even apartheid's opponents have fallen prey. Silvermine is little more than a large modern radio and communications centre sitting astride South Africa's single most important overseas link, the undersea cable from Cape Town to Portugal. There are radio links between Silvermine and other centres—but these are unreliable, insecure, easily jammed, and limited to one channel only. The "insecure reserve circuit" to Whitehall (as the Ministry of Defence called it) existed until the Simonstown agreement was terminated last year. But if the South Africans wanted to call the Royal Navy, picking up the telephone would be quicker more reliable, and practically more secure. □

Nuclear fission and war

Published today is a biography of Frédéric Joliot-Curie, the French physicist who became resistance fighter, communist, high commissioner for atomic energy under de Gaulle, and leader of the World Peace Movement*

Maurice Goldsmith is director of the Science Policy Foundation, London

In June 1939 in *Naturwissenschaften*, Dr Siegfried Flügge, of the Kaiser Wilhelm Institut for Chemistry, published a paper called clearly and directly "Can the energy contained in the atomic nucleus be exploited on a technical scale?" He assumed that two or three free neutrons might result from each split uranium atom. Because of this, he argued, there could be a chain reaction in a large lump of uranium. He expressed this as follows: "One cubic metre of consolidated uranium oxide powder weighs 4·2 tons and contains 3000 million-million-million-million molecules, or three times as many uranium atoms. As each atom liberates about 180 MeV (about three ten-thousandths of an erg), in other words three million-millionths of a kilogram-metre, a total energy of 27 000 million million kilogram-metres would be liberated. That means that one cubic metre of uranium oxide would suffice to lift a cubic-kilometre of water (total weight: 10 million-million kilograms) 27 kilometres (17 miles) into the air!" But how could this enormous energy, which could be unleashed in a fraction of a second, be freed under full control? He suggested the use of cadmium as a "neutron brake". (A cadmium solution was on hand when on 2 December, 1942, the first man-made nuclear chain reaction was demonstrated in Chicago.) This was an interesting, thoughtful paper, which heightened the interest of the Germans in the possibilities arising from atomic research. Flügge was not aware that not any "large lump of uranium" would do for the fission process, but only uranium-235. Also, that a moderator would be required to reduce the velocity of the free neutrons.

It was fear that the Germans might be able to make an atomic bomb that caused some refugee scientists to suggest that free publication in this field be stopped. Between January and June 1939 more than 50 research articles on uranium fission were published in England, France, Germany and the United States. Early in that year, on 2 February, the Hungarian physicist, Leo Szilard, wrote to Frédéric Joliot-Curie from New York asking him not to publish the results of his research into the fission of uranium. His letter read in full:

> "The only reason for my writing to you this letter today is the remote possibility that I shall have to send you a cable in some weeks, and if that happens this letter will help you to understand what the cable is about. This letter is therefore merely a precaution, and we hope an unnecessary precaution.
>
> "When Hahn's paper reached this country about a fortnight ago, a few of us got at once interested in the question whether neutrons are liberated in the disintegration of uranium. Obviously, if more than one neutron were liberated, a sort of chain reaction would be possible. In certain circumstances this might lead to the construction of bombs which would be extremely dangerous in general and particularly in the hands of certain governments.
>
> "It is of course not possible to prevent physicists from discussing these things among themselves and, as a matter of fact, the subject is fairly widely discussed here. However, so far, every individual exercised sufficient discretion to prevent a leakage of these ideas into the newspaper. In the last few days there was some discussion here among physicists whether or not we should take action to prevent anything along this line from being published in scientific periodicals in this country, and also ask colleagues in England and France to consider taking similar action. No definite conclusions have so far been reached in these discussions, but if and when definite steps are being taken I shall send you a cable to tell you what is being done.

In 1935 the Joliet-Curies were awarded the Nobel prize for chemistry "for the synthesis of new radioactive elements". It was the third such award to the family: Marie and Pierre Curie in 1903, Marie Curie in 1911. There was to be a fourth, when in 1965, Henri Labouisse, husband of Eve was awarded the Nobel peace prize as director general of UNICEF

> "We all hope that there will be no, or at least not sufficient, neutron emission and therefore nothing to worry about. Still, in order to be on the safe side, efforts are being made to clear up this point as quickly as possible. Experiments at Columbia University are in charge of Fermi and will perhaps be the first to give reliable results.
>
> "Perhaps you have also thought of the same things and have contemplated or started such experiments. Maybe you are able to get definite results at an earlier date, which, of course, would be very valuable help towards ending the present disquieting uncertainty. Whatever information on the subject you might care to transmit by letter or cable at some later date, will, I am sure, be greatly appreciated. Also, should you come to the conclusion that the publication of certain matters should be prevented, your opinion will

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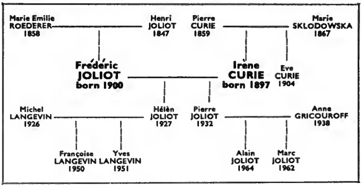
* *Frédéric Joliot-Curie*, by Maurice Goldsmith, is published by Lawrence and Wishart, £7. See p.652 for J. G. Crowther's review.

certainly be given very serious consideration in this country."

Szilard was making this proposal to all scientists he considered to be in the anti- or non-Hitler camp. Two months later, a telegram from New York to Halban made the same proposal. Joliot recorded that "It was the morning of April 1st, and I was sitting in my bath, when round the door came a hand holding a telegram. I was told it was 170 words long and that it came from Slizard and Weisskopf. I opened it to find that it consisted of a plea that the Joliot team should not publish any further results. The Germans, it was suggested, might be able to utilise them in the construction of a nuclear weapon; it would be better if nuclear physicists insisted on a self-denying ordinance—at least for the time being." At first Joliot thought it was an April Fool's joke, "Then I began to realize, it must have been a very expensive joke. For the first time I wondered if the idea was meant to be taken seriously." Szilard wrote also, on 7 April to Joliot enclosing a manuscript for personal information, sent to *Physical Review* on 16 March. He explained that its publication was being delayed "for reasons of which you know. A definite policy in this respect was formulated on March 20th and I was on the point of cabling you on that day when I was told about your note to *Nature* ["Liberation of neutrons in the nuclear explosion of uranium", vol 143, p 470]. I have cabled to you yesterday in reply to your cable to Weisskopf who returned to Rochester, N.Y.) and when we shall have your cable reply the matter of withholding publications may come up again for discussion." The cable answer from Joliot meant "No".

On 19 April Joliot wrote to Szilard thanking him for his interesting note on the liberation of neutrons. He added, "We have continued our research on this question and you will find herewith the MS. of a note we have sent to *Nature* ["Number of neutrons liberated in the nuclear fission of uranium", vol 143, p 680]. Unfortunately, it is too late for us to add a reference to your communication, but we will not fail to do so in a general article which will be published shortly." Joliot went on to say he was very embarrassed by the question of delay in publications on this subject, as he was certainly one of the first to comprehend Szilard's reasons. "However, you do understand that we are not, in addition to those you have been able to warn, the only ones to be concerned with this question, and suddenly we have been able to read in scientific publications and in the press in France and abroad articles which explain clearly the energy consequences of the phenomenon in question. These are the only reasons which have motivated the terms of my last cable. I am certainly in agreement with the principle of an understanding, but for it to be effective it must spread to *all* the laboratories capable of occupying themselves with the question. I would be thankful if you would communicate these views to the American colleagues you have been able to affect."

Joliot thought the proposal ran contrary to the free internationalism that was the essence of scientific activity. Of course, he could not under any definition be regarded as anything but anti-Hitler, but in this regard Joliot felt than on principle open publication must continue, or else Hitler would have succeeded in destroying another precious liberty. He continued to publish openly until war was declared.



There was, however, one limiting factor on full publication: it arose from the prospects of industrial application of the new knowledge. Joliot had discussed the question of patents with Marie Curie. Her attitude was clear. It had been defined many years ago, following the discovery of radium. She told Joliot, "As our work has led to some general scientific activity, similar attempts were being made abroad. Pierre Curie, in this case, adopted the most disinterested and liberal attitude. In agreement with me, he gave up any material profits from our discovery; as a result we did not take out any patents and we published without reserve the full results of our research, as well as the processes used in the preparation of radium. Furthermore, we gave to those interested all the information they asked for. This was a great benefit to the radium industry, which was able to develop quite freely, at first in France and then abroad, and to provide scientists and medical men with the products they required." The Joliot-Curies had taken the same attitude in their discovery of artificial radioactivity; no patents, no holds over anyone.

But, atomic energy was different. There was every likelihood of a war. In March, Hitler had annexed what remained of Czechoslovakia after the Munich agreement. There was one way in which they could seek to make sure that France might still retain her great lead in this vastly important new field. It was through patents. Joliot's team consisted of Halban, Kowarski and Francis Perrin. They were probably the most advanced group in this field in the world. They took out five patents on the construction and utilisation of nuclear reactors; three in the names of all four, and two in the names of Joliot, Halban, and Kowarski*. They transferred the ownership of these patents without delay to the CNRS, which, after the war, handed them over to the French Atomic Energy Commissariat (CEA). On 1 September, Bohr stated that theoretically the isotope uranium-235 was the element of choice for fission chain reaction. This was in a paper, with his former student, John Wheeler, published in the *Physical Review*. But Joliot's secret work showed that a chain reaction could be obtained with natural uranium, if mixed with it were certain substances made up of light atoms susceptible, by slowing down of neutrons, of increasing the opportunity of recreating fissions in the heart of uranium-235.

France, and Britain, declared war on Germany on 3 September. On 30 October, Joliot deposited a sealed document (No. 11620) at the Académie des Sciences. It was not opened until ten years had gone by, on 18 August 1948. The document dealt with "the possibility of producing in a medium containing uranium unlimited chain reaction". It was signed by Joliot, Halban and Kowarski. The report was clear proof that P. M. S. Blackett was right when, in 1960, he said, "At that time, that is towards the latter part of 1939, it is possible that Joliot and his colleagues had carried realistic thinking about the practical possibilities of extracting useful power from uranium further than any other group in the world."

But there was still a great deal to be done. Some of Joliot's colleagues were to help resolve the many uncertainties, and to take part in the practical application of the scientific discoveries, in which he played so essential a part. With the war, his laboratory was taken over for national defence research, and—as he wrote to his mother —"I hope to work to forget the stupidity of men." ☐

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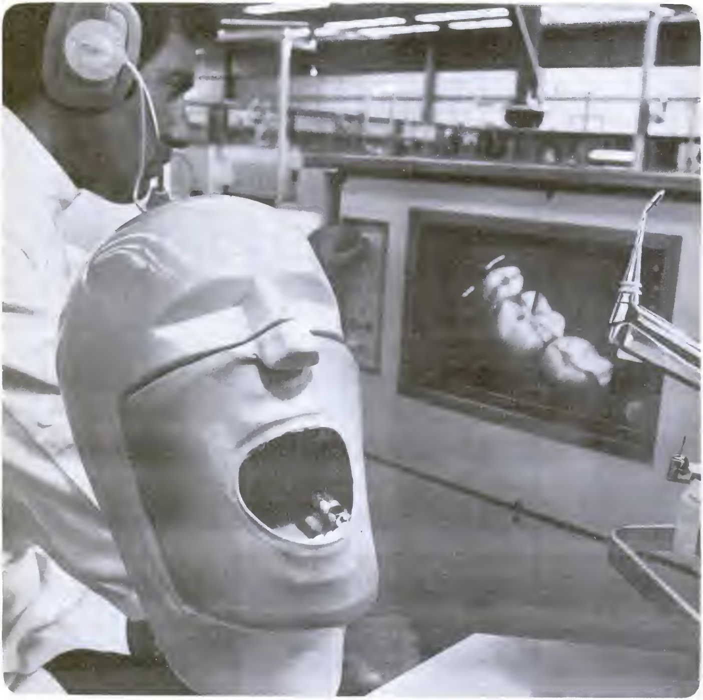
* The patents were: No. 976.541, asked for on May 1, 1939; No. 976.542 on May 2, 1939; No. 971.324 on May 4, 1939; No. 971.384 on April 30, 1940; and No. 971.386 on May 1, 1940. These were not delivered until 1950 and not published until 1951.

Painless

In the medical school of the University of Utrecht dental students work on sets of teeth fixed into the mouth cavities of plastic heads. Beside each chair are a TV screen and earphone.

The professor - who is in what amounts to a small TV studio - works on an identical set of teeth. A small TV camera photographs him, and the picture, along with his verbal instructions, is transmitted to the TV screens and earphones beside the chairs. Consequently each student has a clear view of what the professor is doing and can practise it himself immediately. Since the camera has a 200 mm lens the professor can show either the whole mouth and the position of his hands, or an extreme close-up of, say, the point of the drill.



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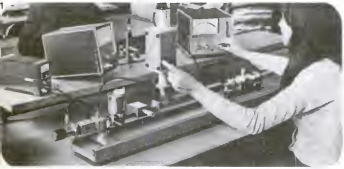

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Habitat: the final reckoning

Confrontation at Vancouver was neither unexpected nor disastrous

Jon Tinker

The western press has pictured Habitat as a promising meeting rudely shattered by Third World intransigence. I believe this assessment to be inaccurate, a depressing reaction to the failure of the Euro-American bloc to get its own way for once. The media's gloomy image partly reflects its own lack of interest: neither of the two big US TV networks was represented in Vancouver, nor were any newspapers from France, West Germany, Italy or Switzerland.

Confrontation there undeniably was. The Group of 77 used its overall majority to force through a Declaration of Principles denouncing "any form of colonialism, foreign aggression and occupation, domination, apartheid and all forms of racism and racial discrimination condemned by the General Assembly of the UN". Since the General Assembly had recently resolved that zionism was racialism, the West considered this a direct and unacceptable attack on Israel.

The declaration was put to the vote, and passed by 89 to 15, with 10 abstentions. Those voting against were Israel, the US and Canada, the European Nine plus Norway, and Australia and New Zealand. Austria, Portugal, Spain, Sweden, Switzerland and Japan abstained, as did four developing countries: Colombia, Honduras, Paraguay and Fiji.

This was certainly confrontation, but it was not entirely of the 77's making. The USA had itself proposed that a vote be taken on the whole declaration, instead of finding a procedure whereby each clause could be considered alone. That would have allowed Israel's friends to have voted against one out of a total of 69 clauses, and then to have joined with the majority in accepting the whole declaration by acclamation—or at worst by abstaining on it.

Nor was confrontation unexpected. President Luis Echeverria of Mexico spelled out the dangers in an opening speech: "This conference is part of the great theme of our times, the division of our world into a bloc of abundance and an enormous archipelago of poverty". And the Palestine issue was not irrelevant to Habitat, whose debate on the deliberate planning of human settlements could hardly exclude Israel's use of such a policy to strengthen its hold on the West Bank.

To the developing world, zionism is the philosophy behind Israeli aggression, the most stubborn—nay expansionist—bastion of colonialism. To Europeans, zionism is the obverse of fascism, and guilt for our past treatment of the Jews is in danger of poisoning our relations with the Third World.

I believe the Group of 77's stand to have been ill-advised, but their passionate concern for the dispossessed Palestinian nation is by no means ignoble. It springs from a sense of justice and human dignity which derives directly from the West's own political tradition.

Vancouver's confrontation was unsurprising for another reason: Habitat was the first major international gathering since the Group of 77 became a coherent and disciplined bloc. After years in which the UN has been dominated by the American and the Soviet camps, with their client states obediently following them into the lobbies, the Third World nations found this new power exhilarating. They often functioned at Vancouver as a private caucus—presenting their diktats as arrogantly as many Labour groups on local councils in England.

Although UN conferences of this type have traditionally operated by consensus, there is no reason why they always should. Most democratic institutions include majority voting among their procedures, so such a novelty can hardly be said to have sabotaged Habitat. Indeed, the UN is surely strengthened by its ability to accommodate deeply-felt dissent on the Palestine issue and still reach consensus on almost everything else.

Of course, it can easily be argued that Vancouver's agreement on a wide variety of major issues—four of them, planning, land, participation and water are discussed in a Comment on p 618—has little if any real meaning. The Declaration on Human Rights, for example, is not observed exactly scrupulously by the Soviet Union or Chile, by Spain or Uganda, by Indonesia or South Africa. However, these and other countries have all found it necessary to defend their conduct against the yardsticks laid down by the human rights charter. And even in the devalued currency of diplomats, few countries sign pledges without some thought for the morrow.

In most of Latin America, to suggest any limitation on the rights of private landowners to do what they wish with their "own" land is regarded as tantamount to communism. Vancouver will at least put these points on the national agenda. And although such discussion may remain concealed within the bureaucracy, its effects are bound to be felt eventually. A senior UK planner from the Department of Environment told me that he had learned a great deal from his formal and informal contacts at Habitat, and expected its effects to diffuse throughout the British administrative machine within a few years. The same is true to a far greater extent in developing countries, where the political process moves faster and governing élites are more closely knit.

A cry for empathy

Concepts which were unheard of outside the environment movement before Stockholm in 1972 are now openly accepted in scores of capitals. Indeed, the very word Stockholm has become historical shorthand for a period when man looked at what he was doing to his planet, and stood back appalled. Stockholm, though, represented a relatively dispassionate concern, an alarm at the chemistry of the atmosphere and the depletion of the whales, a love of nature rather than a love of man. Vancouver's call has been more anthropocentric, a cry for empathy among humankind. It is an expansion of the theme Indira Gandhi spoke of in Stockholm, when she charged that poverty was the worst form of pollution. Pierre Trudeau got it exactly right when he asked Habitat for "a conspiracy of love"—Teilhard de Chardin's conspiracy of men with men and of humanity with the universe.

I am not decrying the anger which men feel at the wanton destruction of wildlife, the rape of a rainforest for a few paltry tons of timber, the savage gouging of fields and hills for the metals buried beneath, the careless fouling of the air or the pollution of a rushing stream. But the failure of the world community to feed, shelter, clothe, heal and educate all its members is to most people a far greater outrage.

Vancouver marked an important advance on Stockholm's call for the conservation of nature. *Eco-development,* while accepting the constraints of the natural environment, is more centred on man than was conservation. IUCN has defined the term as the development of each locality so as to take the fullest sustainable advantage of its physical, biological and cultural resources.

"Let Vancouver be remembered," said Barbara Ward and her colleagues three weeks ago, "as a city where a new hope was born." I think it will be. ☐

A chemical answer to energy problems

Chemists in America have developed the first artificial compound that can release hydrogen from water simply by absorbing visible light from the sun. Hydrogen is a possible future fuel.

Dr Roger Lewin

A chance observation led David Whitten, professor of chemistry at the University of North Carolina, to a discovery that could have an important bearing on future energy supplies. Whitten and his colleagues have developed the first artificial chemical compound that can split water into hydrogen and oxygen simply by trapping the visible light from the sun. Hydrogen is frequently proposed as a pollution-free fuel, but so far there are no economically viable techniques for generating the gas. Whitten told *New Scientist* that the North Carolina system "Could have a fairly good potential" for being developed into that elucive means of production.

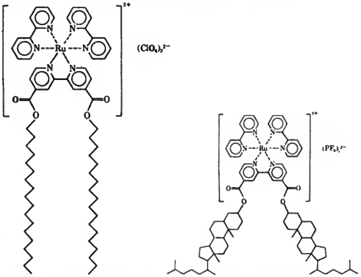
Energy experts and photochemists have been interested in water-splitting mechanisms for some while: producing hydrogen from the relatively limitless supplies of water and sunlight is obviously attractive, especially as a replacement for natural gas, the first of the natural energy supplies likely to run out; and the chemical mechanisms involved in the process are fascinating. Sir George Porter, director of the Royal Institution in London is intrigued by both aspects of Whitten's development, and admits that he is baffled by the chemistry: "How on earth can this work?", he says. Porter, who is keenly interested in developing chemical methods for storing the sun's energy says that at the moment "we cannot do photosynthesis in vitro, but I am absolutely confident that we shall". Whitten's system may be the breakthrough that is anticipated.

In his researches Porter has been concentrating on complexes based on manganese, principally because this metal is known to be involved, in some as yet mysterious way, in the production of oxygen in photosynthesis in green plants. So far he has had little success with the system. Meanwhile, Whitten and his colleagues started work on their compound, which is based on the transition metal ruthenium which snuggles in a complex between ring structures based on bipyridyl residues (see diagrams). Incidentally, this structure is very reminiscent of the active centre of chlorophyll, the green pigment in plants responsible for absorbing light and exploiting its energy.

For water to be split by light, the energy in the light must first be trapped and then passed on to the components of liquid water (hydrogen and hydroxyl ions). This is not the end of the problem, however, as any hydroxyl radicals and hydrogen atoms which appear as intermediates have a strong predilection to reassociate and form water again or to react with and destroy the organic complex. It appears that the ruthenium complex can cope with both these stages.

The ruthenium complex (without the long tails) is an orange/red colour (absorbing at 377 and 430 nm), and it fluoresces a deep red colour when illuminated. This happens because, when the complex absorbs light, an electron in the ruthenium becomes "excited" and rises to a higher energy level. When the electron tumbles back, the energy is released as light; in this case it is the deep red colour (660 nm). Normally the complex continues to fluoresce when it dissolves in water. Whitten's key observation was that when long tails are tagged on to the ring, thus making it insoluble, the luminescence stops when it is added to water. This implies that, instead of being released as light, the energy from the tumbling electron is being trapped in some way—was the water trapping the energy?

The answer turned out to be yes, and by coating the complex onto a small glass sheet, Whitten found that not only was the energy passed on to the water, but the hydrogen and oxygen components were split—*and* they remained separate: a gas containing molecular oxygen and hydrogen bubbled off. Why it works is a mystery, but the curious molecular arrangement must have something to do with it: the ruthenium complexes sit on the glass surface with the tails sticking up like a field of corn. Whitten suggested that the multi-complex organisation forming the monolayer on the glass may be important in keeping separate the potentially reactive oxygen and hydrogen intermediates. What of the layer of "corn", the chemical tails that makes the complex insoluble in water? "The water structure may be modified by this layer, perhaps forming monomeric water", Whitten speculates.



Ruthenium (Ru) appears at the centre of a complex of bipyridyl residues. The long tails (octadecyl residues, on left, or dihydrocholesterol, on right) are required to make the complex split water to release hydrogen

So far the monolayer is the only way in which the complex can be exploited to split water, emphasising the importance of the regular organisation. The efficiency of this system is remarkably high: the quantum yield (that is the proportion of activated molecules which go on to react) is 10 per cent, a figure as high as many plants, and higher than most. Although the efficiency is high, there are problems with scaling up. Whitten confesses, "We don't know how the monolayer will stand up as a practical system; this is a major problem." It may be possible to stack the monolayers, either on top of each other, or on the glass sheets, to increase the overall light absorption. But there are questions such as the life of the catalyst to be settled too, and this is important because ruthenium is very expensive.

Ruthenium is rapidly making a name for itself in mimicking natural catalytic systems. Just recently, a ruthenium complex was developed which can convert atmospheric nitrogen to ammonia, a process which normally can be achieved only by the plant enzyme nitrogenase, or by industrial processes demanding heroic use of high temperatures and pressures. Ammonia is of course an important basic material for fertilisers. Ruthenium therefore finds itself in the unusual position of being at a convergence of fascinating chemistry and important commercial processes. ☐

Review

The patchwork mouse

by Joseph Hixson,

Feffer and Simons, £5·15

"When the two young women came out onto Third Avenue in Manhattan's East Seventies it was still pitch dark . . ."

Such is the unlikely opening of this skilled and colourful description of what the author calls "politics and intrigue in the campaign to conquer cancer". The book is a fully informed, well-written account of contemporary cancer research, and of its accompanying financial hassles, particularly in the United States. The central plot, however, is the disgrace of Dr William Summerlin, the young dermatologist who two years ago confessed to the scientist's gravest sin—that of fabricating experimental data (*New Scientist*, vol 62, p 156).

The two young women were secretaries who worked for Summerlin at the Sloan Kettering Institute, New York. They were out early on 26 March, 1974, because they were on their way to a champagne breakfast with their boss. He had been making controversial claims to have transplanted skin between unrelated mice, without immunological rejection, simply by growing the tissue for a while *in vitro* before grafting. Other researchers had failed to reproduce his findings, and after breakfast he was to see *his* chief, Dr Robert Good, to assess the situation. One of the errors to which he later confessed was that of using a felt-tipped pen to make it appear that two white mice had accepted skin grafts from unrelated black mice. He did this in a lift on the way to the meeting.

Good didn't bother to examine the mice closely, and it was a laboratory assistant who discovered the forgery later in the day. Summerlin admitted the incident at once and later pleaded extreme stress and exhaustion, caused by a heavy work load and the demand for results, as its cause.

The committee which investigated the affair (and which recommended that Summerlin be offered leave of absence) found much more evidence of misrepresentation of data, combined with a disinclination to answer persistent criticism and questioning by other scientists. (Professor Leslie Brent in London was one of the doubters who had tried but failed to get hard practical information out of Summerlin.)

As Hixson makes abundantly clear, Summerlin was deeply at fault. Trying to explain to the review committee why other successfully transplanted mice were not available, he offered the absurd excuse that they had to be killed to provide serum. He had not used "double-blind" methods in assessing skin grafts. And he continued to misrepresent work on corneal transplants, for publication, even after being suspended from the institute.

A major unresolved question is the degree of blame that attaches to Robert Good, director of the Sloan Kettering. One of the merits of *The Patchwork Mouse* is that the author leaves the verdict up to his readers. What is clear is that, despite a formidable reputation as a pioneer of the immunological approach to cancer, Dr Good had annoyed a lot of people at the institute, not least by the extraordinary support and freedom from supervision given to his protegé. He had, it seems, continued to enthuse about Summerlin's "discoveries" even after having good reason to suspect their significance. Thus Summerlin was on the bill at what Good calls a "show-and-tell session" for the press as late as February 1974.

All of this happened in the midst of a spending spree and a scramble for funds that pushed the institute's deficit of four million dollars in 1973 to seven million by the end of 1974. Spectacular results (Summerlin's work, if valid, could have demolished one of the central tenets of immunology) would undoubtedly have been valuable.

Hixson tells the story soundly and honestly, in a potential best-seller that illustrates science writing at its best. He is also careful to remind us of Paul Terasaki's recent work on the immunological changes that occur when lymphocytes are cultured *in vitro*. Despite Summerlin's confession, there remains the tantalising possibility of *some* significance in his claims.

On the whole, the US science writing community comes out of the affair with credit for its determination to get the record straight. None the less, there is evidence in this book of the problems that can arise when, against deadlines, newspaper reporters and editors have to decide how to handle a complex, controversial and incredibly newsy story. So it is nice that Hixson ends his book by urging his American readers "who feel short-changed in keeping abreast of scientific developments" to subscribe to *New Scientist*.

Bernard Dixon

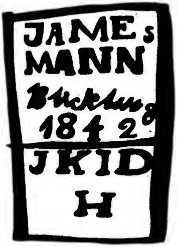
Trees and woodland in the British landscape

by Oliver Rackham

J. M. Dent, £4·95

There seems to be a wave of interest in the makings of the English countryside that will ensure a warm welcome for Dr Rackham's contribution. He has the gift of presenting solid scholarship in a way that kindles the imagination and stimulates the sense of curiosity, as when he writes: "The last approximation to virgin forest in England may have been in the Forest of Dean around 1150 . . . Between 1241 and 1265 Henry III gave 71 oaks out of Dean to make timbers for the Dominican friary at Gloucester *where they remain to this day*. [my italics]. These timbers—perhaps the last remains above ground of the English Wildwood . . . have been sawn from huge oaks, about 2ft 3in in diameter at the middle and 50ft in usable length".

And consider this: if you come upon an area of nettles in an otherwise nettle-free wood, it may be evidence that the site was once inhabited. Dr Rackham's explanation is as satisfying as, though perhaps sounder than, those which kept Watson in thrall to Holmes. Look at the *shape* of a wood. "A re entrant angle may represent the point at which some Anglo-Saxon peasant laid down his twybill after a season's assarting, never to return because of pestilence or the Danes."



Distortion of graffito can give a measure of a tree's age

It is difficult to convey the quality of Dr Rackham's book on the strength of a few quotations. As an aid to understanding the landscape I haven't found its equal. *Ian Low*

Frédéric Joliot-Curie

by Maurice Goldsmith

Lawrence and Wishart, £6

Preceding biographies of Joliot-Curie have presented him conventionally, as an outstanding scientific national and international figure. Goldsmith has approached his subject from an entirely different point of view. In a preface, written as an Imaginary Letter to Joliot, he explains that he wants to look at Joliot to gain insight into himself ". . . to look at myself so that I might better understand my present beliefs and doubts and inconsistencies", for when he was much younger he shared many of the same passions, in the struggle against Fascism in the 1930s and the Bomb in the 1950s.

Goldsmith has therefore been mainly concerned with Joliot's character and behaviour as a human being. He has been assisted by his personal recollections of Joliot, and by long conversations with Joliot's children Hélène and Pierre, and many others. He has had access to the diary kept by Joliot's mother Emilie. He starts with an extract written in 1900. "Monday 19 March: Birth of our dear, little Frédéric . . . The delivery of this big baby was very hard, at 9 in the morning he arrived, red all over."

Mme. Joliot was 42, and her husband 53. Joliot's father was a successful wholesale dealer in calico, and had a comfortable household. He was fond of shooting, fishing and music. Joliot's mother was an intense personality, interested in science and politics. At 18 she had been told by her doctors that she might die at any moment. This prompted her to start her diary, which she kept up for 70 years. It was not surprising that an amiable, handsome, practical man grew up from this background, gifted in relations with people, possessed of scientific genius, and not repelled by politics.

Joliot became deeply involved in politics after he had achieved a major position in science. His involvement arose through the social pressure of the contemporary historical situation. He became a Communist through his experiences in the French Resistance, of which he was ultimately a head, during the Nazi Occupation. He did not consider himself a professional politician; he could deal with and think about politics only as one whose main energies were in science. But he wished to do his political duty. He therefore held that he should defer to the political advice of able men who devoted the whole of their energies to politics.

Picasso's sketch of Frédéric Joliot-Curie

Goldsmith recounts many of the situations in which Joliot found himself, and how, by his actions, he dealt with the political and social problems they presented.

In *Frédéric Joliot-Curie: a Biography* Goldsmith has written an original and interesting book, which should appeal to many readers, both scientific and general. It throws light on how a great scientist dealt with the social, political and personal problems of the 1930-1950 period, and helps the reader to formulate his own ideas on how he should cope with the crises of the 1970s.

J. G. Crowther

University College Hospital London

The operating theatre at University College Hospital, 1898

University College Hospital and its Medical School

by W. R. Merrington

William Heinemann, £7·50

I don't know what the pampered and richly rewarded consultants in our National Health Service hospitals are fussing about. Upset at the prospect of losing their pay-beds, are they? Well, today's malcontents should reflect upon the troubles of Professor David D. Davis deceased. The exercise might cause them to view their own position less bleakly.

The following is from a letter, dated 28 October, 1831, sent by Thomas Coates, Clerk to the University of London, to Lord Brougham of carriage fame, and one of the university's founders.

> Your Lordship will see that Dr Davis's class for want of a Hospital remains very small; as students leave us during the second year of their studies to attend a hospital and it is during that year that midwifery must be learnt.
>
> In order to supply the deficiency in his income Dr Davis is anxious to have the care of some young man of impaired intellect—his house is very large and was fitted up by him for the reception of pupils — a speculation which has not been successful. . . .

Dr Davis was professor of midwifery at the university, which had opened only three years earlier.

He was to receive two thirds of the fees paid by such students as he could attract. But, as Thomas Coates's letter explains, there *were* no students of midwifery, because at that stage the only clinical teaching the university could offer took place at an out-patient dispensary built for the purpose. There were no hospital beds of *any* kind for the professors' use, let alone pay beds for their private patients.

I don't suppose Dr Davis was actually starving, since he had a large private practice, and had set a seal upon his reputation by attending the birth of Queen Victoria in 1819. His colleague, John Conolly, professor of the nature and treatment of disease, who gave up a practice in Stratford to take the post, seems to have suffered greater hardship, for there are letters written by him at the time to the Warden of the university asking for "money on account to meet urgent needs".

These, and a host of similarly fascinating sidelights on the medical life, and the life of the metropolis, during the past 150 years enliven the pages of *University College Hospital and its Medical School: A History.* In 1884 the Medical Committee decided that "the connection of the Hospital with the Telephone Exchange would not be of any advantage to the Staff." A year or two earlier the Resident Medical Officer reported the Senior House Surgeon to the Dan, having found him "at a late hour in the doorway of the Scullery of III, talking to the night-nurse who was in the Scullery". A request for the supply of stronger beer to the Matron's table was refused. One on the hospital rules at the time laid it down that "No nurse shall be employed who cannot read writing". There are numerous vignettes of the great and the eccentric who have been associated with the hospital, including Joseph Lister, Robert Liston, John Snow, Victor Horsley, Marshall Hall and Thomas Lewis.

The author, William Merrington, a sometime UCH surgeon, is now curator of the Medical School Museum. Rarely do amateur historians, particularly those writing about their own institutions, produce such an entertaining, illuminating, and well-ordered work. An excellent holiday read for anybody—even people who don't much care for doctors.

Donald Gould

The lead industry of Wensleydale and Swaledale

Volume 1, The mines

Volume 2, The smelting mills

by Arthur Raistrick

Moorland, £2·95 each

The history of mining has attracted increasing attention in recent years, with the upsurge of interest in industrial archaeology. This is particularly true of non-ferrous metal mining, which has virtually disappeared from Britain as an active industry but which has left a wealth of intriguing landscape features to exercise the imagination of scholars and tourists alike. Old authorities on metal mining, long since out of print, have been re-issued, and new experts have arisen. Among the latter, Arthur Raistrick is an outstanding example, having made himself the master of all aspects of mining and metal processing in the Pennines.

In this new work Dr Raistrick returns to a theme which he has pursued with great energy over many years, and incorporated the fruit of recent research on collections of Quaker records. The result is a handbook that will be of value to everybody who wishes to learn more about metal mining in the Yorkshire Dales. The publishers have chosen to produce it in two slim volumes, the first giving a succinct historical account of the industry and a survey of

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New Scientist (24 April 1975)

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1975, xxx, 673 pp.
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Topics covered in this third volume are: conventional nuclear-fission reactors, breeder reactors, nuclear-energy applications, nuclear strategies, and energy policies. Problems are included at the end of the text.

1976, ready early Fall, about 700 pp., illus.
hardbound ISBN 0-201-05564
paperbound ISBN 0-201-05565

THE REDSHIFT CONTROVERSY

George B. Field, Center for Astrophysics, Harvard College Observatory
Halton Arp, Hale Observatories, Pasadena, California
John N. Bahcall, Institute for Advanced Study, Princeton

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New Scientist

"Reading this fascinating record is a fine preparation for a definitive verdict soon — we hope — to come."
Scientific American

1974, xvi, 324 pp. illus., 8½" x 9¼", 2nd printing, 1976
hardbound ISBN 0-805-32512-3
paperbound ISBN 0-805-32513-1
Frontiers in Physics Series, No. 39,
Edited by David Pines

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Edited by Harold A. Linstone, Portland State University **and Murray Turoff,** New Jersey Institute of Technology with a Foreword by Olaf Helmer

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Joseph P. Martino,
Technological Forecasting and Social Change

1975, xx, 621 pp., illus.
hardbound ISBN 0-201-04394-0
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J. F. Whitfield, Head of Animal and Cell Physiology Group, National Research Council of Canada

SPACE STRUCTURES
Their Harmony and Counterpoint

Arthur L. Loeb
Carpenter Center for the Visual Arts,
Harvard University
With a Foreword by Cyril Stanley Smith
Massachusetts Institute of Technology

Addressed to a widely-varied audience this new book is a general theory of three-dimensional structure involving interrelations and transformations between polyhedra, and ways of combining them into three-dimensional nets. An original concept and a unique contribution to Design Science, it will challenge undergraduate and graduate students and appeal to specialists with a mathematical inclination and interest in the underlying patterns of interactions between things.

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STRUCTURAL STABILITY AND MORPHOGENESIS
A General Theory of Models

René Thom
Institut des Hautes Etudes, Bures-sur-Yvette

Translated from the French edition by D.H. Fowler, updated by the author, with Forewords to the original French and updated English editions by C.H. Waddington.

About "catastrophe theory" -

"Thom's work is called 'catastrophe theory' because it describes phenomena (not necessarily disasters) that jump abruptly from one form of behavior to a radically different one. The theory has been hailed as an 'intellectual revolution' in mathematics — the most important development since calculus — and can be used in the social and biological sciences as well as the physical ones . . . an enthusiastic and growing coterie of mathematicians has begun to apply the theory to practical problems, with what they say are remarkable results." — *Charles Panati, Newsweek*

1975 (2nd printing, with corrections, 1976).
xxvi, 348 pp., illus.
hardbound ISBN 0-805-39278-5
paperbound ISBN 0-805-39279-3

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01867, U.S.A.

the principal mines, and the second being devoted to the 43 sites of smelting mills that Dr Raistrick identifies. Presumably this is a cost-conscious effort to persuade purchasers to buy the book in easy installments, but as the field worker will almost always need to be able to consult both volumes on any one expedition, it is an uncertain economy. Moreover, it must be said that the standard of printing and of reproduction of photographs is disappointing, and that there has been some laxity with typesetting which includes a misspelling in the title of the first chapter.

Apart from these blemishes, the work is an important addition to knowledge of this now obsolete industry, adding valuable supplementary material to the author's own earlier work and to such excellent illustrative texts as R. T. Clough's *The Lead Smelting Mills of the Yorkshire Dales*. Dr Raistrick, who is 80 this year, has been indefatigable in his mineralogical studies of his native Yorkshire, and in the course of writing this latest book he has visited all the mines and their remains again. Many people will share his sadness at the deterioration of field monuments during the past few years, caused largely by ignorant vandalism. This seems to be the price which has to be paid for any increase in popular interest in contemporary society, but it should not be necessary. *Angus Buchanan*

Job satisfaction

Challenge and response in
modern Britain
edited by Mary Weir
Fontana/Collins, paperback,
£1·75

With well over a million unemployed it is perhaps not surprising that we have heard rather little in the past few months about "job enrichment". There it a certain irony involved in trying to improve the content of jobs when the preoccupation of so many is to get a job or to keep the one they have. However, the debate about job satisfaction is only muted at the moment and will re-emerge as soon as there is any improvement in the economic situation, while the issue of "participation" will flare into life as soon as the Bullock committee reports later this year.

The most publicised of job enrichment experiments is undoubtedly the Swedish Volvo plant at Kalmar. But in Britain there have also been some initiatives which have received official encouragement in the past three years from the Tripartite Steering Group on Job Satisfaction, on which are represented the CBI, the TUC and the Department of Employment. The group oversees the activities of the Department's "Work Research Unit".

For anyone interested in the way in which these developments have occurred in Britain and in examining the intellectual underpinning of the subject, this collection of readings, edited by Mary Weir, will supply a good introduction. The extracts are well chosen, they provide a good coverage of a diffuse field and they are grouped logically into seven sections. These include, first, a sample of the proselytising writings which have led to the use of the word "movement" to describe the activities of those who normatively advocate "life in work". There are two sections, one of which traces the development of job satisfaction theories mainly by American management psychologists over the past 40 years and the other which concentrates on current theoretical contributions in Britain. There are six case studies of practical applications and in the last section a series of extracts which critically evaluate what has been achieved and attempts the essential task of placing the experiments and the debate in the wider context of the total work situation.

The reader will be left with many questions. How valid is the evidence for any connection between job satisfaction and productivity or good industrial relations? What aspects of the work situation are "motivators"? What, if any, are the constraints on radical changes in the structuring of jobs? Are they technical—for few of the case studies describe situations where the technology itself was redesigned—or do they relate to more fundamental issues of power and authority relations in industry? How far do initiatives in this area reflect yet one more attempt by management to solve the inherent conflict which arises from what Alan Fox describes as the "low trust relationships" characteristic of business life where "specific services are offered in exchange for specific sums of money"?

It is clear that the issues are both more simple and more complex than some enthusiasts for the "quality of working life" would have us believe. Yet at the same time a book of readings of this kind underlines how essential it is that engineers and scientists should understand the social implications of what they are doing in the industrial field. Technical decisions cannot be divorced from the social structures which give rise to them.

Dorothy Wedderburn

Planning or prevention?

by Peter Diggory and
John McEwan
Marion Boyars, £1·95
(hardback, £4·95)

"As medical men we are often the guardians of female virtue," asserted one doctor in the 19th century—an era when women using any form of birth control were threatened, in retribution, with calamities from sterility to "repulsive nymphomania". Even today, many medical Jeremiahs still cling to their self-appointed guardianship, say the authors of *Planning or Prevention?*, who question therefore whether doctors are really the best people to administer contraception.

In a book refreshingly free from both medical jargon and emotion, Peter Diggory and John McEwan look at present and past attitudes to contraception, abortion and sterilisation, along with the advantages and deficiencies of the different methods available, details of the techniques used, and the physical and psychological effects. They are able to demolish some popular myths on the way, and to answer such questions as whether vasectomy affects virility, what is the most effective form of birth control, the real dangers of the pill, and the causes of foetal abnormality.

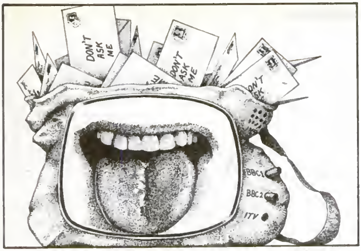
The authors also discuss the more complex problems of teenage pregnancies, how much a man should be involved in decisions over contraception and abortion, and the best way of tackling the present lack of adequate sex education. They try to place "individual family planning" in the wider context of population control. And this control, it is argued, can only be achieved if couples are motivated rather than dragooned into having fewer children. As they say, poorer couples look on a large family as security—which means that despite the unflagging zeal of the sterilisers in Third World countries, the answer lies in improved living standards, not reduced fertility. In any case, emphasize Diggory and McEwan, the West needs to sort out its own moral hang-ups over sex and family planning before it is in a position to preach to the Third World. *Joy Melville*

Audience

by X.L.

At one time, science on television was the province of the BBC and nothing but the BBC. The moguls of ITV clearly did not believe that there was much popular interest in science, *Horizon* had never hit the ratings high. Of the ITV companies, Yorkshire is still the only one to have a department that regularly produces science programmes. It has just finished a series of 30-minute documentaries, *Discovery*, the last programme of which, "Death of a Disease", covered the eradication of smallpox. More interesting, perhaps, Yorkshire has just come back with its third series of *Don't Ask Me*, which seems to be the first programme to put science high in the ratings.

Don't Ask Me is a variant on the panel show. Members of the public send in questions such as: why does a flag flap the way that it does in the breeze?, or why does your tongue look like it does? These questions are answered by a trio of energetic experts, Magnus Pyke (extrovert of extroverts), Miriam Stoppard and David Bellamy. Yorkshire says it has been consistently impressed by how people's questions are often based on very good observation and stress that the 6-12 questions which are answered in one show are chosen out of literally hundreds. Last year, the *TV Times* gave *Don't Ask Me*



Ingram Pinn

a special award for getting more response from the public than any other show.

Don't Ask Me is conducted in a slightly frenetic atmosphere. There is an audience from whose members the questions come. The shows are edited on a very tight schedule almost deliberately to give a feeling of pressure and improvisation. Unlike most TV shows where everything is scripted, *Don't Ask Me* is almost entirely ad-libbed from beginning to end.

The show is worth watching both for itself—it is jolly and the questions are good. But also from a professional science point of view, it does often reveal how to convey quite complicated information briefly and entertainingly. I am not suggesting that all science communications need such jazzing up but it might do no harm sometimes or, at least, occasionally. The most ponderous way of putting one's views across are not necessarily the best.

Yorkshire must be very pleased too with the ratings. The first show in the new series was fourth in the Top Ten for the whole network, just behind such popular perennials as *Coronation Street*. It nicely confirms the point that science can make excellent popular entertainment — without becoming either cheapened or inaccurate. Of course, some people may be shocked by the jocular tone of the whole proceeding. Yorkshire emphasises, however, that all the answers it gives are very carefully researched and tested so that the audiences learns as well as being amused.

The series of *Discovery* has been rather less successful. For if *Don't Ask Me* has really invented a new kind of format, *Discovery* often seems like a mini-*Horizon*. And there have been some rather poor programmes. The prize for dullness must go to the programme on amateur scientists which looked at three people, a radio astronomer, an entomologist and an underwater archaeologist. The programme could find nothing more to say than that they all did it for the love of the subject and that, maybe, they were a bit nutty. What profound insight! Since their contributions had to be crammed into the 30 minute format (and none of the work seemed that fascinating *per se*) one neither learned about them—how does being a science freak fit in with work and life? how real are the contributions they make?—nor about the scientific usefulness of their work. A programme on the use of microscopes in surgery was a little better though again too diffuse. At times, it seemed to be a list of all the different medical specialities which could use microscope surgery. "Death of a Disease" traced in broad outline the conquest of smallpox since 1966 in an undramatic though not particularly illuminating way. Perhaps when *Discovery* returns in the winter probably—it can try to find a more distinctive style of its own.

* * *

Peter Goodchild, the editor of *Horizon*, complains (Letters, 13 May) that I projected an unjustified image of his programme. It is not going to harp on "fringe" popular topics like the Bermuda Triangle. He claims I can only have got my information from "an incomplete source", which is certainly an evocative phrase conjuring up, as it does, some spokesman with only half a head. Alas, the truth is duller. I got all my information from the BBC Press Office that deals with *Horizon* and I think, I included every programme they told me about in the future plans including the Gold Gold Gold programme, which was not a *Horizon* at all. Incidentally, one of my higher degrees was in chemistry, hence my boldness in daring to criticise *The Chemical Dream*.

I must also take issue with Peter Goodchild's point that the film about the labyrinths at Chan Chan. It never mentioned Van Daniken—and I didn't say that it did—but it was shot, laden with mystery, so that you expected one of the gods to be landing out of the chariots any minute.

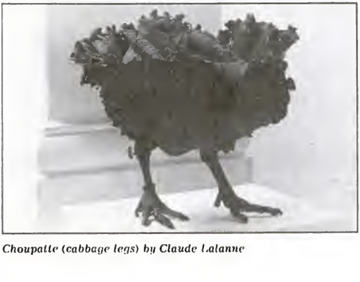
Art

Les Lalanne

Whitechapel Gallery, London, until 4 July

Les is not short for Leslie but for François-Xavier and his wife Claude, both born in France, he in 1927 and she has forgotten when. My guess is 1934.

They have wit, imagination, panache, gracefulness, manual and visual dexterity, resourcefulness, fire, tools, a sense of texture, nostalgia, a feeling of space and volume, and Frenchness. They make *choses*. F-X works on the bigger scale. His polyester hippo makes a comfortable bath, with the head providing a well-plumbed wash-basin: full allowance is made for modesty as the bather can pull over himself the dorsal skin, carefully hinged and freely moving. The tin of sardines—one of the many pieces of furniture—is soft and comfortable and funny: it represents almost an unrealistic lapse in this all but surrealist world in that the sardines have kept their heads. An avian set of garden furniture consists of an egg, a small, a medium, and a large bird, all made of cool Carrara marble: what a shame that one of the wings was broken—no doubt the cat had been at it which is why it is not exhibited. There is, as you will discover, more than one way of dispensing toilet-paper, and camels, low and unaromatic, provide most comfortable seats. The duck-boat (with propellers that do not turn) is one of the mega-toys, and of added interest because it shows how F-X follows his pencilled design.



Choupatte (cabbage legs) by Claude Lalanne

Claude, on the other hand, follows her intuition. Less intellectual but more musical than her husband, she garlands a love-seat—rather a demure one for these days—by swivelling spiralling metal through space, and, as it were, peels cutlery from the trees of her dancing imagination. A rabbit chewing a cabbage, undergrowth all but chewing a marmot, a cabbage with legs, flora and fauna are intertwined until one's head begins to spin. But when it comes to the apple with the mouth, with lips modulated as if they were the only pair in the world, which they are, of course, then the continuous smile turns breathless for a moment and subsides.

Robert Weale

Forum

OUT AND ABOUT

Mountains of the Moon

John Hillaby

Somewhere in his autobiography, Graham Greene says that the books we read in childhood and adolescence influence us more profoundly than any kind of religious instruction or example and though this territory is more for exploration by my esteemed colleague, Pig Ignorant, than myself, I shall trespass therein, wandering down a trail blazed initially by those masters of evocation, Joseph Conrad, and Thomas Stearns Eliot, and may God forgive us our trespasses.

How I came to be reading both the *Heart of Darkness* and *The Waste Land* in a caravan perched high up in the Valley of Desolation can be attributed to the weather which, in Wharfedale at Eastertide can be very wet indeed, and I was a youngster and yearning to be out and about on derring-do and, as I have implied, the rain came down in stair rods.

"The *horror* of it." The line is from that disillusioned mystic who ventured far up the Congo and saw what he could not sum up except in four words on his death bed. The horror of it? Those fugitive tribesmen, those enormous trees hanging over the steaming river? I absorbed every drop of moisture except his conclusion and, somewhat disillusioned myself, turned to *What The Thunder Said*, for April, as we all know, can be the cruellest month, breeding lilacs out of the dead land, mixing memory and desire, stirring dull roots with rain.

The scene, as they say, changes. Near 40 years had leafed off the all too deciduous calendar before, with two companions, Richard Foster Flint, the glaciologist from Yale and Jean de Heinzelin of the *Parcs Nationaux du Congo Belge* and I forget how many Wanande porters, I stood on the high ridge above the Black Lake and looked down on the lunar vegetation of the Ruwenzori, the Mountains of the Moon on the western rim of Uganda.

"We saw groundsels (*Senecios*), swollen and distorted with woody trunks, twenty feet in height, lobelias like gigantic blue and green obelisks, heathers mighty as great trees. Most alpine plants are reduced to extreme dwarfness, but these have rushed to the opposite extreme and exhibit an exaggerated gigantism." A great botanist and plant hunter whose name I'll come to in a minute likens them to "a weird and terrible dream." He says a grey mist made a fitting background for the most monstrous and unearthly landscape he had ever seen. "Vague outlines of peaks and precipices towered around us. Here were trees and plants which seemed more like ghosts of past ages than ordinary trees and herbs."

Our objectives can be dismissed briefly. Foster Flint sought some correlation between the Pluvials of the tropics and the Glacials of the high northern latitudes. Jean de Heinzelin warded us, surely, taking specimens of the bacteriostatic water from which the Belgians hoped to extract an anti-rheumatoid agent, the product of broken down uric acid from the roots of the groundsels.

At night, at 14 000 feet, we had difficulty in sleeping and listened to the high-pitched trill of hyraxes and the [illegible] that preyed on them. And throughout the long days we gazed at those phallic vegetables thrusting through the mist. What had brought about that unearthly gigantism?

Theories are legion, and, as far as I know, unproven; [illegible] I had scarcely time to think or speculate. Enough [illegible] Pliny's Country of the Anthropophagi whose snow he believed

fathered the Nile. It wasn't a bad guess. The river has changed course several times and among our porters were two fellows believed to be *Yam-yams*, a polite word in a variant of Kiswahili for cannibals. I looked and marvelled at everything.

The scene has changed again. When it poured down the other night I sat in this cottage, reading a splendid book, *In Search of Flowers* (Michael Joseph, 1973) by Patrick M. Synge, for years the editor of the Royal Horticultural Society's *Journal*. If you imagine for one moment that *Senecios* are but weedy groundsels and sticky ragworts, woundworts and fleaworts, you should digest his exotic compilation.

He says that when the glaciation in the north fell back, the icecaps on the African mountains also decreased and in some cases, as on Mount Elgon, actually disappeared. As the icecaps retreated up the mountains we may assume he says, that the cold-loving plants also followed them until they reached their present positions. The mountain floras do not really begin till a height of 7000 ft. Thus we may assume that the different mountain floras became isolated from one another and evolved separately. Each mountain top is a little garden where evolution may have proceeded uninfluenced by the rest of lower Africa. I read and re-read his words and also his epigraph from that same T. S. Eliot:

Old men ought to be explorers
  Here and there does not matter
We must be still and still moving
  Into another intensity . . .

Such an opportunity exists. Some TV people have a notion that cameras can capture what I hold most dear in memory and imagination. Pig Ignorant, keep me from sin. ☐

ECONOMICS

Power of the £

Anthony Renton

As I write, the sterling-dollar exchange rate is hovering about \$1·72 to the £. This compares with the \$2·60 to the £ settled upon by the world's central bankers at the Smithsonian meeting (supposedly to re-shape the international monetary order) as recently as December 1971. Since that time the £ has depreciated against a trade-weighted average of the currencies of our major trading partners by 4 per cent. This average depreciation has now been added to the Treasury's regular state of the [illegible] list of "key economic indicators"—a sure sign of the times we live in.

The explanation for the sharp depreciation of sterling favoured by bankers is the "purchasing power parity" hypothesis. This hypothesis was first advanced by Cassel in 1918, when [illegible] new exchange [illegible]

[illegible] and hence the demand for it depends upon the quantity of goods and services that a unit of the currency will buy in the country of issue, ie the inverse of the general price level. The value of the £ relative to the $, say, and hence the exchange rate, is held to be determined by their relative internal purchasing power.

The PPP is thus defined either as the ratio of domestic to foreign countries' price levels (the "absolute" version) or as the product of the exchange rate in some base period and the ratio of the countries' price indices (the "relative" version).

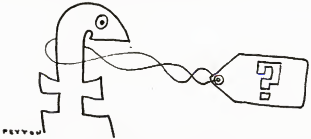
In either case the long-run equilibrium exchange rate—that is, the rate that would yield a zero balance of payments over some lengthy period, in the absence of special policies (eg internal deflation or tariffs) to avoid payments imbalance—is asserted to be critically dependent upon the PPP, and the rate that actually exists under a freely floating exchange rate system is asserted to tend to the long-run equilibrium rate. The PPP is held to be the critical determinant of the exchange rate; any divergences between the actual rate and the PPP will be small or, if large, temporary.

So, in asking what the exchange rate is likely to be in equilibrium, what matters are relative rates of inflation. The relative form of the PPP hypothesis says: Pick a period in the past when conditions were "normal" both at home and abroad, multiply the exchange rate in this base period by the ratio of the change in the domestic price level since that period to the change in foreign prices, and the result should be the current equilibrium exchange rate. If $2 cost £1 in the base period, but British prices have risen twice as much as US prices since then, then the new equilibrium rate will be $1 for £1.

The absolute version of the theory says: Calculate the price today of a standard bundle of goods in the UK (in £ terms) and in the US (in $), and the equilibrium exchange rate will be that price of $ that equates the costs of these two bundles. Thus, for example, if the chosen collection of goods cost $17 in America and £10 in Britain, the equilibrium rate would be $1·7 to £1.

Since the end of 1971 the price of British output has nearly doubled whilst the comparable US price has risen by only 38 per cent. Both the absolute and the relative versions of the PPP suggest therefore that, if exchange rates had been free, the $:£ rate would be about $1:£1. This simple calculation casts grave doubt on the government's claim that the depreciation of the £ in recent months has been over-done—particularly as our inflation rate will exceed that of our major trading partners for a further year or so.

Of course December 1971 might not be an appropriate base period. There are problems in calculating the PPP to do with the price indices chosen; in general, the PPP will vary with different indices because of differences in their weighting patterns. The existence of tariffs, quotas, transport costs and other impediments to trade will give rise to a deviation of the short-run equilibrium exchange rate from the PPP. The existence of price and wage controls in the UK means that the buying power of sterling is not properly reflected in market prices, particularly as the prices of non-traded services have risen quickest due to the ending of public sector subsidies.



However, the disparity between the PPP and the actual exchange rate seems so great that, whatever the data deficiencies, sterling is likely to depreciate much further. Confirmatory evidence for this is given by the extent of government intervention in the market to prop up the rate by selling forign currencies for sterling irrespective of price. In the past three months over $3000 million of reserves have been used in support of sterling. Despite this, the rate has continued to fall.

We still have very substantial lines of credit to draw upon. But to attempt to peg the exchange rate at its current level is likely, in view of our past and probable future inflation rates to prove just as expensive and futile as the 1964-67 attempt to maintain the $2·80 pound. □

WESTMINSTER SCENE

Tuberculosis visitors

Tam Dalyell MP

After the long argument about hybrid bills, and the regrettable events that followed, which produced oceans of press comment at home and abroad—my European Parliament colleagues feared that every British MP who actually arrived in Brussels would be disfigured and on crutches—it is not surprising that a Private Member's Ten Minute Rule Bill did not warrant a mention.

I refer to Anthony Steen's Tuberculosis Visitors (Health and Chest Clinics) Bill. I was unaware until I heard Steen, Liverpool, Wavertree, say that the number of tuberculosis cases in Britain was starting to rise again. In 1975, there were 12 323 outbreaks. Steen is vexed about what he sees as the discrimination currently practised against the tuberculosis visitor, if she does not possess a health visitor's certificate.

Of the 140 tuberculosis visitors, most are experienced state registered nurses, usually with other qualifications as well, such as state certified midwives. However, of the 140, fewer than six hold a health visitors' certificate. Yet the visitors are part of the National Health Service, and work from chest clinics, where physicians say that they are invaluable and indispensable in monitoring and detecting tuberculosis.

At present, if a nurse has the health visitor certificate, her status is enhanced, and she is raised in pay and pension rights to the equivalent of a Ward Sister 1. If she does not have the health visitor certificate, she is demoted to the bottom rung of the nursing ladder, to staff nurse. Whereas, in 1970, the tuberculosis visitor without the health visitor certificate was on an intermediate scale between staff nurse and sister earning £180 less than the tuberculosis visitor with the certificate, the Halsbury proposals raised the differential to £1248, while downgrading those without the certificate.

Steen pointed out that if the tuberculosis visitor has the health visitor certificate, not only is she paid more, and gets a higher pension, but she is three grades higher than her colleague doing identical work in the same office, in the same area, who takes on the same responsibilities. If the tuberculosis visitor has no health visitor certificate, she is on the same rung as the nurse who has just qualified, or perhaps back to where she started 20 or 30 years ago.

This is clearly an injustice which should be put right for its own sake, but more than that, in view of the alarming trend in tuberculosis, it becomes something of a priority. It is for this reason that the Steen Bill has the sponsored support of his political opponents, such as Alan Beith, the Liberal Chief Whip, and Willie Hamilton, who has taken a sustained interest in nurses' conditions.

* * *

When people complain to me—as they often do—that it is ridiculous that nationalised industries, such as electricity and gas, each have a separate showroom in the same High Street, I tend to squirm a bit. Now, in answer to a question from the secretary of the Scottish group of Labour MPs, Ian Campbell, West Dumbartonshire, who used to work in the gas industry, Tony Benn has made a statement.

He told the Commons that he, along with Bruce Millan, the Scottish Secretary, and Shirley Williams, the Prices Secretary, had received advice from the British Gas Corporation, the Electricity Council, the Scottish Electricity Boards, the National

Gas Consumer Council, the electricity consultative councils, and the representatives of the workers in the two industries, covering a number of trade unions, who had all made a detailed study of the question.

They were unanimously against the merging of electricity and gas showrooms.

Well, I suppose they must know what is right, but I shall still feel uneasy when some irate constituent, faced with a large gas or electricity bill, brings up the matter.

However, some good does seem to have emerged from the study. The consumer representatives have suggested that where one of the industries has to close an uneconomic showroom, the possibility of maintaining some service through the other's showroom should be considered. Benn has accepted this advice, and he is taking up the matter with the chairman of the gas and electricity industries.

The consumer representatives have also suggested that both industries should accept, through their showrooms, payment of accounts for either industry, and I understand that this possibility is being considered in the review of payment and collection methods for fuel bills. As a believer in the "thin end of the wedge theory", I hope that these developments may in practice lead to a more sensible use of resources as between the gas and electricity industries, suspecting as I do that by some curious alchemy many showrooms on something like a 50-50 basis, will suddenly be discovered to be "uneconomic".

* * *

There seems to have been a terrible spate of fires in the home recently. Some of the lethal accidents have been attributed to cellular foam, and a number of MPs, such as Ron Brown, Shoreditch, who is an expert on the furniture industry, and Robert Kilroy Silk are again calling for safeguards.

John Fraser, Minister of State at the Department of Prices and Consumer Protection rightly states the obvious, that the most effective safeguard is to take normal precautions to prevent fires occurring, and he points to the fact that the government and other bodies are already spending a great deal of money, promoting publicity on this subject.

However, following the recent publication by the Building Research Establishment of a report of government-sponsored research on fire hazards of plastics in furniture, the department has asked the furniture trade to take the findings into account in deciding on the composition of upholstered furniture.

The report is now being studied in more detail to see whether additional guidance can be issued, pending the availability of suitable fire test methods now being developed. As a constituency MP, I find that not only are the results of a fire a terrible blow to a family, even if life has not been lost—but very often a fire is an emotional experience, which can lead to changed relationships for the worse within the family. Any money spent on fire hazard research is money well spent. □

PIG-IGNORANT

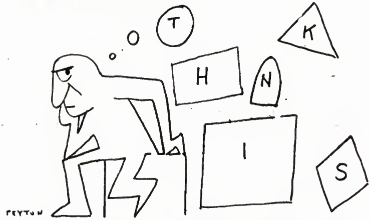
More about philosophy

Peter Laurie

In Pig's last, he ignorantly made some play with a book called *Zen and the Art of Motorcycle Maintenance*—a book which is by no means as dopey as the title would suggest. In fact, it is a downright good read, but, as Huck Finn tells us of another work: "the statements was interesting but tough." The deepest of the several themes of the thing is the eternal struggle between classics and romantics—a theme which has been messed about—under other names—fairly often in these columns.

Phaedrus, the pre-electric-shock personality of the author, is fretting himself about the nature of "quality"—why do we say, for instance, that one mathematical demonstration is more beautiful than another? What essence does the better one have in common with, say a well executed left hook in the boxing ring, or an elegantly shaped chair leg? By a series of refinements he zig-zags down to the central problem, now invoking the dry classical tradition of separation, naming, analysis—the chair leg, for instance, has to be defined as something which supports a chair before it can be felt to be beautiful—if it were seen to be a chair *arm*, it might be thought quite second rate—and now the romantic, non-intellectual, emotional response of appreciation—the belt in the stomach, the squirt of adrenalin.

Having got so far, he then gets himself into a cleft stick by passing on a question put by his faculty colleagues: "Is quality in the object, or is it subjective, existing only in the observer?" Which he says is a "finisher offer . . a haymaker, a Saturday-night special—the kind you don't recover from." And why? Because, he tells us, quality is either in the object and therefore detectable by instruments, or in the observer and therefore a matter of personal taste alone.



Now, this seems to me to be just silly. Suppose the object whose quality is in question is a piece of English prose. It would be hard, at this stage of the game, to make an instrument which would even read the stuff reliably, let alone tell you even whether it was in English or Polish. As to whether it was well written, that is something which no "instrument" will be able to tell for many a long day—and the reason is exactly the problem that Phaedrus originally proposed: to define quality—an emotional reaction, in terms of the classical logic which the machine must use. But on the other hand, even if "quality" is in the observer alone, that does not mean it is trivial, because many others of his culture will also feel it. That is what "culture" means—the existence of common tastes.

But the question is silly on a deeper level. It apparently presents an either-or, "A" or "Not A", as they so boringly observe in the text books on elementary logic. In terms of philosophy this may be fair enough; in terms of some electronic analogue of the brain, it isn't very satisfactory. Anyone who has messed about with electronics will know how miraculous it seems, after only a very few stages of signal processing, to build a circuit that will infallibly light up one lamp when a certain condition is present, and another when it is not.

In real life, sometimes it works, other times it doesn't. The lamps come on together, flicker in chorus, go out for no reason. And this is with reliable old copper, solder and silicon. What about things when you build your circuit out of the junk you can buy in a butcher's shop—and make not just half a dozen stages, but thousands.

That is more or less what our brain is. The notions we have of the world, round which philosophers weave their arguments, are vague, rippling waves of neuronic excitation, related to reality—whatever *that* is, by the interpretation—however, *that* is done—of the impact of photons on millions of other neurons, the oscillation of a little drum of skin by shakings of the air, by pressure on the skin. At the end of all that it is asking a bit much for Occam's razor to shave clean. It's a wonder we think only as crooked as we do. □

WASHINGTON VIEW

Secular humanism

Dan Greenberg

Unfortunate events have created a misleading impression of moral standards in this city, and I wish to apply a corrective. The events I refer to include Representative Wayne Hays's programme to assist the unskilled in finding office employment; Representative Wilbur Mills's support of the performing arts, and John F. Kennedy's quest for relief from the burdens of the presidency, testimony concerning which has been provided by innumerable self-confessed partners—so many that simple arithmetic invites serious doubt or great admiration.

Be that as it may, distant observers should be assured that these well-publicised items are more than balanced by frequent demonstrations of support for the traditional values that made this nation what it is.

For example, last month, the House of Representatives confronted the "religion of secular humanism" and voted to bar federal funds for educational activities that embrace that menace.

The problem of secular humanism was brought to the attention of the House by Representative John B. Conlon, Republican, of Arizona. Mr Conlon, who had earlier made himself noticeable by plaguing the National Science Foundation for its support of social science studies for school children, said that the measure he sponsored was needed so "that no preference be granted to the religion of secular humanism over the Judaic-Christian viewpoint."

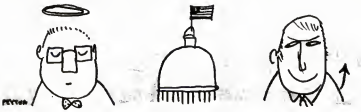
For the benefit of his colleagues who were unaware of the problem, Mr Conlon noted that a recent issue of *Humanist Magazine* contained the assertion that "humanism is alive and thriving in secondary schools.

"Since we are not funding the Judaeo-Christian ethic," Mr Conlon said, "I see no reason why we should be funding another religion that is hostile to the Christian viewpoint."

Representative James G. O'Hara, Democrat, of Michigan, argued back that, in the bill under consideration, "There will not be any 'teaching of secular humanism' . . . one way or the other. I just think we are making ourselves look like a bunch of monkeys if we go on treating amendments like this seriously and adopting them in bills with which they have nothing to do."

Of the nearly 400 members present, no-one else had anything to say on the matter, and the Conlon provision was adopted, 222-174, as an amendment to the National Defense Education Act. Another manifestation of legislative support for traditional values merits note. This one concerns a proposed study to be aided by federal funds, of the effects of marihuana on sexual behaviour, often referred to as the "sexpot" project. Suitable it was on the eve of the Easter recess that the House voted to cut off funds for this venture, which was to be carried out by a researcher at the Southern Illinois University Medical School. An attempt was made to salvage the project in the Senate, but last month, that chamber voted to support the House position.

Faraway friends of this nation should thus temper their despair. Morality is alive and well in Washington—especially in the public sessions of the US Congress. ☐



THE LAST WORD ON

Pneumatic twins

Patrick Ryan

Inflation is gaining ground in other than merely financial fields. As confirmed by the Oxfordshire policeman who gave chase to a passing motorcar because a naked lady appeared to be leaning from the nearside window and waving for help. On overhauling the vehicle, however, he found it was being driven by a gentleman from Banbury with a lifesize, inflatable female doll beside him. And he duly recorded in his notebook the driver's explanation that because his wife had just left him, four of his friends had clubbed together and bought his passenger to cheer him up. "After a few drinks," he added, "I took a liking to the doll and decided to take her for a spin in the country." In court, later, he was fined £25 for travelling with a dangerous load.

Although there is no record of their use as consolation gifts to wives whose husbands had just left them, pneumatic male models were also being marketed in New York just a while back. This masculine version was primarily intended as a security device and, when fully-blown, it was a facsimile of a well-dressed businessman wearing a bowler hat. This "silent partner" as the advertisement proclaimed, "sits beside you so that you are not alone in your car" and, when you park the automobile, "you leave him sitting there and he keeps intruders away." For which latter purpose of scaring off would-be car thieves, it would seem better to have dispensed with the bowler hat bit and substituted instead the menacing poll of Kojak or the forbidding features of Count Dracula.

Further market research might also reveal profitable popular demands for other versions of inflatable, handy-pack people. Principally among which could emerge a hitherto unexpressed need of each of us for a portable, pneumatic *alter ego*, a pocket-size personal Madame Tussaud. How handy it would be for overtired businessmen inescapably condemned to the rat race, if they could buy blow-up facsimilies of themselves which they could leave crouching over their lighted desks deep into the night, so that passing executive vice-presidents would mark them up as "A" for devoted application; although, in actuality, they would be tending to more therapeutic duties at the nearest bar.

Similar reproductions of themselves would be hectically saleable to distraught young mothers for standing at the bedsides of those perverse babies who can blissfully sleep through thunder while the maternal parent is in attendance beside the cot, but who let loose all ear-splitting and squawling hell the very moment the poor girl abandons her frostbitten post to creep hopefully back to bed.

To any weekend agricultural conscript who equates gardening with another day in the life of Ivan Denisovich, an inflatable image of himself which, placed in gum-boots, could be left bent over a spade in the middle of the mud, would not only decieve myopic wives and scare off marauding birds, but would also permit its original to spend the allotted tilling time contentedly drinking light ale in the potting shed.

In realms of greater splendour, monarchs and presidents would pawn their gold plate to pay for pneumatic versions of their noble selves—suitably fitted with small electric motors to provide continuous gracious becking and imperial nodding—which could take their processional places in open carriages on exceptionally wet and windy ceremonial days.

And, at the opposite end of the social structure, there would be a worldwide demand for emergency doubles from the criminal classes of all nations.

And, even should retribution unfortunately overtake them and confine them to the nick for ordained decades, a blow-up personal duplicate could be invaluable for persuading inspecting warders that the prototype is still in bed, whereas in fact he is engaged under the cell floor essaying a latterday Monte Cristo with a sawn-off tablespoon.

But for this last purpose, of course, it would be essential that the inflatable reproduction should be made of suitable gossamer material so that, when deflated, it could be concealed in a fairly large fruit cake. ☐

Letters

Needs of Mankind

Sir,—Can it be that even *New Scientist* is unable to solve the dilemma in which western scientists find themselves? Jon Tinker (Comment, 3 June, p 506) makes some very pertinent comments concerning the irrelevancy of the Habitat conference to much of the world's population. Without wishing to make an age-old (but still unsolved) point too obvious, may I contrast two quotes, appearing on opposite pages of *New Scientist*.

First, Jon Tinker (Comment): "The weary Indian villager who watches a sputnik move across the sky . . . (is) surely not convinced by the argument that the bare necessities of life are an extravagance we cannot afford." Secondly (This Week, 3 June, p 507, "Viking ships its oars"), "Already a flurry of preparations has begun. The reason is a *crucial* need to find out as much as possible about the projected landing site (on Mars) before a soft landing takes place."

My point is not to expose any hypocrisy in *New Scientist's* editorial policy but merely to highlight the still unresolved conflict between the unfettered furtherance of knowledge and the *crucial* needs of mankind.

The politically minded may have an easy answer. I and many others do not.

P. J. Shannon

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Aerosols

Sir—Much as I enjoy, and certainly benefit from, reading about the wise utterings of those who advocate the virtues of that chemical wonder, chlorine nitrate (This Week, 20 May, p 395), I cannot help but feel that our course of action is clear.

Rather than spend our time worrying about our beloved stratosphere we should embark upon a campaign to restrict the use of those arch enemies—the chlorofluorocarbons.

Each CFC emitter, carrying a government warning: "Used in excess causes pressure-belt distortion", would be sure to put the average deodorant-wielder ill-at-ease.

Perhaps though, on reflection, a wiser course of action might be to encourage this aerosol science to develop to its full potential. Who knows, along with the anti-perspirants and floor-polishes of tomorrow, we might see the ultimate "ozone-arranger". This invaluable device would be used to cause local changes in ozone layer concentration, and hence, personal weather control: an end to the "Great British Drought"!

David Waldron

19 Orchard Road
Middlesbrough
Cleveland

Smoggy days

Sir,—Technology (27 May, p 470) reports the highest-ever level of ozone pollution in London (18pphm). Obviously this figure is likely to increase in step with the nitrogen dioxide emissions which follow the increasing ownership of cars.

To comprehend this level of nitrogenous pollution in meaningful perspective can anybody relate the effects of the figures given to the level of pollutants inhaled from tobacco smoke during a day's "normal" cigarette smoking?

Presumably the figures for "tar" products are unhelpful but perhaps the corrosive and irritant potential of the acids of sulphur and nitrogen are sufficiently comparable to permit a degree of extrapolation.

Some of the research into tobacco pollutants might then become instructive in relation to the increasing pollution from cars (leaving out the question of lead).

I once complained to an oil company's pollution expert about the smell from taxis and 'buses; he said "there is no pollution from diesel oil—it it contains no lead".

R. A. C. Hill

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London SE19 1HF

Hydroponics and weather

Sir,—While I agree with the basic principles ("An end to all soil problems", 27 May, p 462) that plant roots need water, oxygen and a nutrient supply, before we can consider the establishment of a practicable hydroponic growing system in this country, we need to consider the complexity of our climatic conditions.

Our experiments so far have been unable to find an acceptable compromise which would provide the amateur grower with a simple non-technical hydroponic growing system able to meet the requirements of our variant weather.

The plants shown in the Glasshouse Crops Research Institute have grown under optimum conditions with all the facilities and technical experience of the GCRI being available. Plant growth is dependent on good weather conditions; it does not matter how much we adjust the nutrient solution we are still unable to compensate for the variations that occur in light intensity, temperature, humidity and wind velocity between March and October.

In conclusion, while we are gratified that hydroponic systems are receiving attention, let us make it clear that we must not use the art as a magic word that will solve all the growers' problems overnight.

W. J. Copeland

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Sutton Coldfield
West Midlands

Science and astrology

Sir,—As a member of the public with both a chemistry degree *and* an interest in astrology, I wonder why, if there is truly no basis for belief in the latter, 168 famous scientists should have felt it necessary to say so! (Feedback, 3 June, p 532). They do protest too much, methinks!

I was particularly disturbed by their assertion that astrology must be suspect "since there is no scientific foundation for its claims". Surely this should be modified to read that "in the light of present knowledge there is no

Grimbledon Down **Bill Tidy**

YOU'RE INSANE. OUR BRIGHTON TRIP WAS ONLY A BIT OF FUN. JUST A PHYSICAL THING! I DON'T LOVE YOU, YOU FOOL!
WHAT ARE YOU DOING WITH THAT HX47?
THEN THERE'S NO POINT IN LIVING!
THE WORLD MUST DIE. THEN WE CAN BE TOGETHER, FOR EVER!
IF I CAN REACH THE ALARM...
BBC'S NEW SCI-FIC SERIES. WHAT DO YOU THINK? HX47. IS IT A COINCIDENCE OR IS SOMEONE FEEDING THE MEDIA? SCOTT, YOU'RE NERVE GAS CHIEF.
HX 47 TOP SECRE
I SAY SHEER COINCIDENCE BUT I'M WILLING TO SIT BACK AND HEAR MY COLLEAGUES OPINIONS.
PSST! WAS IT ONLY A PHYSICAL THING BETWEEN US, DR. SCHWARTZENBERG?

scientific foundation for its claims", a vastly different matter. Many famous scientists of the past were prepared to be more fair than their present-day counterparts, and at least treat the matter with an open mind. Surely we are not to be forbidden to believe in anything which at the moment cannot be scientifically explained? Since it seems that most of modern-day science is based on theories which are proved conclusively today and disproved equally conclusively tomorrow, this state of affairs could lead to considerable confusion in all but the most zealous minds!

As I understand it, astrology does not claim that the planets exert any influence as such at the moment of birth to shape a person's life, but rather that their positions at this time can be taken as a guide to indicate the possible character of the individual and the events which may occur if he follows a particular course. To take a simple analogy, the position of the hands of a clock cannot force a man to get to work at the correct time, but can certainly show him if he is going to be late!

Surely scientists have spent far too much time trying to find rational explanations for astrology, and much too litttle in research to see if it actually works or not. This could only be done by a correlation of the personal horoscopes of many individuals, worked out from date, place and accurate time of birth, with the actual course of each individual's life. In particular, it would be instructive to examine the birth maps of a selection of babies being born at the present time, followed by a long-term examination of how their future lives fit with the predictions made.

Margaret A. McRae
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Household science

Sir,—We have read with great interest the article ("Graduating to consumer science", 3 June, p 536) dealing with the multidisciplinary degree course at the University of Surrey.

As moderators for the B.Ed. Part I Home Economics option within the University of London we were surprised to read that Home Economics has not until now been considered a university subject in Great Britain. Could we draw the attention of the writer of this article and your readers to the B.Ed. degrees in Home Economics in several British Universities and the earliest of all, the establishment of King's College of Household and Social Science in 1908 to teach the domestic arts and sciences at degree level. Admittedly the name of the college was changed to Queen Elizabeth College in 1953.

We are very sympathetic to the aims of the course at Surrey but we feel that due acknowledgement should be given to the founders of Queen Elizabeth College and the University of London who taught the subject of Household Science—as it was then known—for many, many, years.

A. E. Bender
I. D. Morton
Queen Elizabeth College
University of London
Campden Hill Road
London, W8 7AH

Sociopolitics

Sir,—A pity that Professor Hammerton (Letters, 3 June, p 547) forgot to take his inverting glasses off before he wrote, or he'd have seen that he was facing the wrong way. Other readers of my letter (Letters, 20 May, p 433) will surely have noted that I was *defending* science against the ideology of sociobiology; Professor Hammerton has got it all backwards. However, if you are determined to attack someone for their politics, I don't suppose it matters reading what they write first.

Steven Rose
Biology Department
The Open University
Walton Hall
Milton Keynes

School hazards

Sir,—I hope it is not too late to congratulate you on the excellent article on the "Hazards of School Science" (vol 69, p 550).

Before coming to teach in Kenya I was head of chemistry at a school in England and can confirm many of the frustrations of acquiring proper safety devices mentioned in the article.

The main chemistry lab used for classes of 30 up to O-Level was on the first floor and had only two doors both

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Letters

continued

at the front of the lab where the demonstration bench was. It was only after years of nagging governors, science inspector, fire officers and anyone else whom I thought could do something, that a door was made at the back of the lab. I tried, unsuccessfully, to acquire small hand fire extinguishers to be fitted to each bench, rather than one or two large ones which needed two people to invert and direct at the fire.

When we acquired another chemistry lab, it was only because we had an excellent science inspector that we were given a portable fume cupboard for it. A permanent one would have been too expensive, although the portable cupboard could not be used for all chemicals because it had a polythene tube which went out of a window.

My biggest worry was the chemicals cupboard. It was approximately 6ft × 10ft and contained all the chemicals. The bottles of acid stood on the wooden floor. There was nowhere to keep highly volatile chemicals separately, and until a fan was installed, again the work of an excellent science inspector, one almost needed a gas mask to enter the room.

Margaret J. Edwards

Maseno Secondary School
P.O. Box 120
Maseno
Kenya

Metrication

Sir,—Following your correspondents on metrication (Letters, 3 June, p 548) I must add my own example of "metric madness".

As a former scientist it might be assumed that I would have no difficulty in visualising metric measurements. It is a little disconcerting to find I have a 97 bust measurement.

However, the extreme lunacy seems to me to be the manufacturers of elastic who have gone over to packing 1 metre of elastic in a mass of cardboard and Cellophane—in the good old days I could buy elastic by the yard, and since 30 inches of elastic was adequate to go round my waist and overlap for a join, it is simple to calculate that with five yards of elastic I could do the job six times over. Now I buy one metre and have almost ten inches to waste—I have yet to do the arithmetic necessary to discover how many metres I would have to buy to achieve no waste—at a rough guess it looks like 76 metres! Where do I find a shop to sell me a length of 76 metres?—though with current inflation it might be a good investment.

I. A. Derriman

34 Mossville Gardens
Morden, Surrey

Tantalizer

No. 454 On the cards

From a complete pack I take two cards chosen from the kings, queens and jacks. I mark one 'A' and the other 'B'. Your task is to identify A and B, given that the ranking of suits from the top is Spades, Hearts, Diamonds, Clubs and that 'if' does not mean the same as 'only if'.

1. If A is black, B is a jack.
2. A is a queen, only if B is a diamond.
3. A is a heart, only if B is black.
4. A is a king, if B is a spade.
5. A is a club, if B is a king.
6. A is a heart, if B is a heart.
7. If the higher is a queen, the lower is a heart.
8. The lower is a jack, only if the higher is a heart.
9. If the lower is red, B is a spade.
10. The higher is red, only if A is not a king.

Martin Hollis

Solution to Tantalizer No. 453

The school play

Tom was an angel and the others bunnies. T2 is true (otherwise T1 is contradictory), making D2 true and H2 false. If D1 is true, T is the only bunny and T2 would be false after all.

Earthquake

Sir,—Mischa Markert's (Letters, 27 May, p 488) account of interference on the VHF waveband during an earthquake was extremely interesting. However, his suggestion that the interference was of cosmic origin implies the difficult hypothesis that an earthquake can affect the electrical properties of the higher atmosphere.

Is it absurd to suggest that the interference might have had some sort of piezo-electric origin, stemming from pressure changes in the rock strata? *Andrew Nahum*

52 India Street
Edinburgh 3

Taxing solutions?

Sir,—Robin Clarke's "Windmill Economics" (Forum, 29 May, p 484) may encourage the more entrepreneurial among us to start building, but in matters of this sort society imposes, alas, a law of, not so much diminishing as abruptly truncated, returns.

Within a couple of years of it becoming clear that Windworks Incorporated *can* compete with the CEGB we shall have a Windmill Tax.

The future of our Sceptred Isle is a great deal more predictable than we like to think. The only unknown is what excuse will be offered: protection of the environment perhaps.

R. Capewell

49 Toms Lane
King's Langley
Herts WD4 8NA

All in fun

Sir,—It is unfortunate in this age of so-called freedom of speech, that those who have climbed on the various bandwagons of TM, AT, fringe politics, Gay Lib., and all the other products of our "permissive society", have to take themselves so painfully seriously.

Patrick Ryan's harmless bit of fun-poking (Forum, 22 April, p 194) evidently upset Denis Postle (Letters, 3 June, p 548), but surely it did no more damage than Bill Tidy's regular weekly dig at the scientific establishment.

J. R. Court

Microbiology Department
Queen Elizabeth College
University of London
Campden Hill Road
London W8 7AH

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A RESEARCH ASSISTANT

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Applications with a curriculum vitae and the names of two referees to Professor J. R. D. Francis, Civil Engineering Dept, Imperial College, London, SW7, from whom further details may be obtained.

UNIVERSITY OF LIVERPOOL

Department of Histology and Cell Biology (Medical)

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Further details and applications to Professor D. A. Mitchison (Honorary Director), Department of Bacteriology, Royal Postgraduate Medical School, DuCane Road, London, W12 0HS.

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The Co-ordinator, University of London/University of Riyadh, London School of Hygiene and Tropical Medicine, Keppel Street, London WC1E 7HT from whom further particulars are obtainable.

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Department of Geological Sciences

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CITY OF LONDON POLYTECHNIC

Department of Metallurgy and Materials

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(Grade 3) required in Plant Science Laboratories, University of Reading. Duties include making and handling bulk sterile solutions. Some experience and ONC or equivalent desirable. Salary in scale £2325-£2655 p.a. Apply with full details and names of two referees, quoting Ref. T.S. 25A, to Assistant Bursar (Personnel), University of Reading, Whiteknights, Reading, Berks RG6 2AH.

CONSERVATION OFFICER

required by the Cheshire Conservation Trust. Experience of nature reserve plans and practice. Salary £2300-£2800 plus allowances. Details from the Trust—2, Pear Tree Lane, Acton Bridge, Northwich CW8 3QR.

Tropical Products Institute,
Culham, Oxfordshire

Chemical Engineer

■ **To evaluate a variety of chemical engineering unit operations, mainly concerned with processing post-harvest products of developing countries ■ Emphasis on crop drying and heat exchanger design and distillation ■ Responsibility for design and development of processes, plant and equipment ■ Possibility of overseas trials.**
□ Good hons degree or equivalent in Chemical Engineering □ At least 4 years' post-graduate experience, preferably with some in designing chemical engineering process plant and equipment □ Age normally under 32 □ Appointment as Senior Scientific Officer (£4500–£6090) □ Ref: SA/64/JD.

■ *Application forms (for return by 9 July 1976), from Miss C A Hall, Tropical Products Institute, 127 Clerkenwell Road, London, EC1R 5DB.*

Centre for Overseas Pest Research,
London

Biologist (Molluscicides)

■ **To study the mode of action of molluscicides using liquid scintillation counting and autoradiographic methods, in order to use them for control of bilharziasis and faciolíasis.**
□ 1st/2nd hons degree or equivalent in a biological science, with at least 2 years' appropriate postgraduate experience □ Age under 3c □ Appointment as Higher Scientific Officer (£4030–£5230) □ Ref: SA/33/JA.

■ *Application forms (for return by 15 July 1976), from Mr H Woodman (MOLHSO), Ministry of Overseas Development, Centre for Overseas Pest Research, College House, Wrights Lane, London W8 5SJ.*

Ministry of Agriculture, Fisheries and Food
Pest Infestation Control Laboratory
Tolworth, Surrey

Computer Scientist/ Biometrician

■ **To help develop and run a unit processing data for rodent research ■ Department equipped with a Hewlett Packard 9830, supported by an ICL Computer ■ Participate in wide variety of research projects and surveys ■ Research into improving data collection and analysis ■ Opportunities to extend work to other vertebrate and invertebrate pest problems.**
□ Degree or equivalent in Computer Science or Statistics □ Interest in biometrics desirable □ Age under 30 □ Appointment as Higher Scientific Officer (£3830 – £5030) or Scientific Officer (£2775 – £4150), according to age and experience □ Ref: SB/27/AF.

■ *Application forms (for return by 9 July 1976), from Civil Service Commission, Alencon Link, Basingstoke, Hants, RG21 1JB, telephone Basingstoke (0256) 68551 (answering service if office closed) or London 01-839 1992 (24 hour answering service).*

Science Group
CIVIL SERVICE

AUSTRALIAN NATIONAL UNIVERSITY

Faculty of Science

SECOND CHAIR OF FORESTRY

The University invites applications for appointment to a second Chair in the Department of Forestry. The Department has major responsibilities as the national school of forestry education at tertiary level in Australia. It has extensive contacts through education, research and development aid with many countries, particularly in Asia.

The interests of the person appointed should complement those of the Head of Department, Professor D. M. Griffin, whose principal interests are in forest pathology and microbial ecology. Professor Griffin was appointed as Head of Department in 1975 for five years with eligibility for re-appointment as Head. The appointee to the second Chair will be expected to accept appointment as Head of Department, if so invited, at some time in the future. The electoral committee will be particularly interested to receive applications from persons with experience in forestry practice and forest use and a special research interest in some aspect of these areas. It will wish to appoint a person with wide knowledge and a broad vision of the future of forestry in Australia. The University hopes that the appointee will be able to take up duty not later than early 1977. Enquiries concerning academic aspects of the appointment may be addressed to Professor Griffin.

Appointment as professor is immediately to retiring age (65 years). Current salary as Professor is $A25 955 per annum.

Reasonable travel expenses are paid and assistance with housing is given for an appointee from outside Canberra. Superannuation benefits are available.

The University reserves the right not to make an appointment or to make an appointment by invitation at any time.

Further particulars should be obtained from the Association of Commonwealth Universities (Appts), 36 Gordon Square, London WC1H 0PF.

Applications close on 6 September, 1976.

BRUNEL UNIVERSITY

Department of Polymer Science and Technology

Applications are invited for a postgraduate research post for the synthesis of novel polymeric materials. The post is sponsored by Dowty Seals Ltd.

Application forms and further particulars from Dr K. A. Hodd, Department of Polymer Science, Brunel University, Uxbridge, Middlesex.

TECHNICIAN GRADE 3

required for ELECTRON MICROSCOPE UNIT equipped with an EM6 B and Corinth 275 under a Supervising Technician. Applicants should have suitable qualifications for general e.m. and photographic work. Commencing salary within the scale £2325-£2655 p.a. plus £465 p.a. London Weighting. 5 day week. 5 weeks' annual holiday. Application forms may be obtained from the Assistant Secretary (Personnel), Bedford College, Regent's Park, London NW1 4NS. Telephone: 01-486 4400 Ext. 312.

JUNIOR TECHNICIAN

to join team working on Diabetic Research. "O" or "A" levels in science subjects an advantage. Please apply with full curriculum vitae to R. Woolner, Department of Medicine, St Thomas's Hospital Medical School (University of London), London SE1 7EH.

Looking for a career opportunity?

If you have at least 'A' level standard of education – preferably in Chemical or Biological Sciences, why not join HOECHST, one of the world's largest chemical and pharmaceutical groups, as a

Medical Representative!

In promoting the Company's products to the Medical and allied professions you will use a blend of personal and technical skills. Selling experience is not necessary as full training will be given.

In joining Hoechst you could be taking the first step towards a progressive career with an international company where training and development are top priorities.

Salary and benefits are of the high standard expected of a major company. A Company car will also be provided.

Vacancies exist in Durham and North Yorkshire; Derbyshire, Nottingham and North Notts; East London postal districts; South London postal districts, for a training course starting in September.

If you think you could meet the challenge of being a Hoechst Medical Representative, then telephone or write for an application form to:

Mrs. M. C. Hannay, Assistant Personnel Manager, Hoechst UK Limited,
Hoechst House, Salisbury Road, Hounslow, Middlesex.
Tel: 01-570 7712.

Hoechst

A DIFFICULT ASSIGNMENT

The Paint Research Association requires a Principal Research Officer who could help in promoting the scientific/technical work of the Association and be able to make a major contribution in sales of research contracts.

The person appointed will probably have post-graduate experience to PhD level and will provide evidence of success both in personal researches and the management of a small research team. He/she will have experience in two technologies to include one advanced application of either polymer chemistry or colour technology, together with broad-ranging interests in the sciences and technologies. He/she must have a sound appreciation of the economics of R & D and its money-making or money-saving exploitation in industry. He/she will have a business like personality and ability in logical and persuasive communication.

Preferred age: under 40 years.

Anyone earning less than £4500 is unlikely to have the experience required.

Applications, marked "Personal and Confidential", should be addressed to:—

Dr G. de W. Anderson, Director, Paint Research Association, Waldegrave Rd., Teddington, Middx. TW11 8LD.

THE UNIVERSITY OF MANCHESTER

Department of Pharmacy

EXPERIMENTAL OFFICER

Applications are invited from graduates in chemistry, biochemistry or a related science for this new post. The successful candidate will develop methods for determination of drugs in biological fluids, using modern chromatographic and radioactivity techniques, help plan and run kinetic experiments in animals and man, and help in processing the data using computational techniques. Initial salary in range £2766-£4602 p.a., superannuation under USS. Particulars and application forms returnable by 12 July) from the Registrar, The University, Manchester M13 9PL. Quote ref: 116/76/NS.

LABORATORIES ● LIMITED

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BIOCHEMIST — DRUG METABOLISM

This international Company requires a Biochemist to head a small section working on pharmacokinetics and metabolism studies of new drugs.

Candidates should have some experience in this field, or with chromatographic and radio-chemical techniques associated with the identification and quantitation of drugs.

The successful applicant, aged preferably 22-30, will be educated to degree level and be able to work on their own initiative.

A highly competitive salary will be envisaged, related to qualifications and experience, and facilities for part-time studies to higher degrees would be considered.

The appointment carries attractive conditions of employment, including 4-weeks' holiday, a biennial bonus scheme, Pension, Life Assurance and B.U.P.A. benefits and a subsidised staff restaurant. A flexible working-hour trial scheme has also been introduced.

Please write, giving personal particulars and full details of relevant practical experience to:

A. R. Taylor,
Laboratory Controller
Servier Laboratories Limited
Servier House,
Horsenden Lane South,
Greenford,
Middlesex, UB6 7PW

SCIENCE MUSEUM

Research Assistant

(Physics)

. . . to make an in-depth study of classical scientific instruments (1600 – 1850) in the Department of Physics. Duties include advising on the acquisition of such instruments; developing the Museum's index of scientific instrument makers and answering enquiries about these craftsmen; helping in the redeployment of the physics collections, mainly by carrying out research.

Candidates should normally have a degree or equivalent qualification in a science, engineering or mathematical subject, or in the history of science, or history if the degree is backed by a proven interest in this aspect of history. Reading knowledge of French or German essential.

Salary (Inner London): as RA Grade I £4030 – £5230 or RA Grade II £2925 – £4305. Level of appointment and starting salary according to age, qualifications and experience. Non-contributory pension scheme.

For further details and an application form (to be returned by 9 July, 1976) write to Civil Service Commission, Alencon Link, Basingstoke, Hants, RG21 1JB, or telephone Basingstoke (0256) 68551 (answering service operates outside office hours) or London 01-839 1992 (24-hour answering service). Please quote ref. G(24)382.

PLYMOUTH POLYTECHNIC

RESEARCH ASSISTANTS

Applications are invited for the following research appointments which are now available.

Environmental Sciences

Two vacancies are available from October 1976, for students wishing to undertake research in one of the following areas:

1. **Structure and Physiology of Fish Receptors**
2. **Cretaceous micropalaeontology**

Maritime Studies

Tidal Streams in the English Channel

Applications are invited from suitably qualified graduates to join a research group working on tides and surges in the English Channel and Celtic Sea. Candidates should have a first or upper second class honours degree in oceanography, meteorology, nautical science, mathematics, computation or a related subject.

Mathematical Sciences

Rheology

Applications are invited from candidates with, or expecting to obtain a good honours degree in Mathematics to work on the flow properties of cement pastes. Applicants with qualifications in relevant Engineering fields may be considered.

All of the posts demand high academic qualifications and where appropriate some industrial experience. Research Assistants are normally required to register for a higher degree, although post-doctoral applicants can be considered.

Appointments are for a period of two years with the possibility of a third year, and carry an initial salary of either £2469 or £2721 with annual increments. An additional £312 p.a. supplement is also payable. Research Assistants undertake 6 hours teaching weekly.

Send for further details and application form to Personnel Officer.

Closing date for applications will be 30 June, 1976.

PLYMOUTH POLYTECHNIC DRAKE CIRCUS
PLYMOUTH PL4 8AA

UNIVERSITY OF ST ANDREWS

Department of Biochemistry

Applications are invited from recent graduates for a post of Research Assistant tenable for three years in the Department of Biochemistry. The person appointed will work with Dr G. Kemp on a project financed by the MRC on the structure of fibrinogen and its degradation products. Starting salary £2766 plus superannuation (USS).

Applications with details of career and the names of two referees should be sent to the Establishments Officer of the University, College Gate, St Andrews, Fife, by 30 June, 1976.

TWO RESEARCH POSTS IN IMMUNOLOGY

mainly concerned with cell-culture techniques in the fields of candidiasis and immunodeficiency. Access to immunofluorescent and immunochemical training. Opportunity for Higher Degree. Candidates with AIMLT (or expecting it in August) who wish to take the Special Examination in Immunology are also invited to apply.

Salaries according to current Whitley scales up to £3,600 pa. Applications, with two referees, to Professor J. R. Hobbs, Westminster Medical School, 17 Page Street, London SW1P 2AR, by 9 July, 1976.

Clinical Biochemist for Toxicology

Roche Products Limited is amongst the leaders of the Pharmaceutical Industry in the United Kingdom and is itself part of a major international group of Companies with its headquarters in Switzerland. Its Research Function is well established and includes a purpose-built Toxicology Department, with up-to-date and well-equipped laboratories.

We need a Clinical Biochemist to work in the Department, within our team of senior technicians, responsible to the Head of Department. The Clinical Biochemist undertakes analysis of body fluids from non-human primates and other animals used in toxicological studies. Opportunity exists for research into the clinical biochemistry of primates and the Company will encourage the development of methods of assay.

It is essential for applicants to have had considerable experience in clinical biochemistry, preferably in connection with animal toxicology of drugs or allied materials. They should hold a relevant first degree or a recognised technical qualification such as FIMLT or MI Biol.

The Company's Conditions of Service are excellent and include competitive remuneration which should attract those currently earning in excess of £3750 per annum.

If you would like to apply for this interesting opportunity please write enclosing brief career details or telephone (Welwyn Garden 28128) for an application form quoting reference RG10 to M. N. Davies, Personnel Manager.

ROCHE

Roche Products Limited
PO Box 8 Welwyn Garden City Herts AL7 3AY

Royal Military College of Science, Shrivenham

PHYSICIST/ENGINEER

BALLISTICS RESEARCH

...is required to join a small team at the start of an investigation into blast and shock wave diffraction effects. The study will have a significant experimental content and postgraduate research experience will be an advantage.

Candidates should have an honours degree in Physics or Engineering, preferably with some knowledge of fluid mechanics. Accommodation for single staff is available and there is the possibility of housing for a married candidate. Appointment is for 3 years, as a Higher Research Scientist (£3567–£4767).

For further details and an application form (to be returned by July 1976) write to Civilian Admin. Officer, Royal Military College of Science, Shrivenham, Swindon, Wilts, telephone 0793 782551 ext. 421. Please quote reference SC/23/EP.

ROYAL POSTGRADUATE MEDICAL SCHOOL

TECHNICAL OFFICER

An Electronics Engineer with BSc or equivalent qualification is required to assist in the design and construction of an automated system for recording isopotential electrocardiographic surface maps. The project will be conducted jointly with the Engineering in Medicine Laboratory at Imperial College and the appointment is for three years and is available immediately. Salary according to qualifications and experience on scale up to £3699 per annum.

Applications to the Personnel Officer, RPMS, 150 Du Cane Road, London W12 0HS (01-743 2030 Ext. 93) quoting ref. no. 2/NS.

THE UNIVERSITY OF MANCHESTER

LECTURER IN ZOOLOGY

Applications are invited for the above post from candidates with qualifications in Vertebrate Zoology. Experience in physiological aspects applicable to field studies would be advantageous. Initial salary £3174-£3786 p.a. Superannuation. Particulars and application forms (returnable by July 22) from the Registrar, The University Manchester, Manchester M13 9PL. Quote ref: 118/76/NS.

UNIVERSITY OF WARWICK

RESEARCH PROJECT MANAGER
in the
Department of Engineering

Applications are invited from engineers or applied mathematicians for the post of Project Manager (male or female) for a major research project being undertaken by the Inter-University Institute of Engineering Control (Universities of Bangor, Sussex and Warwick). The duties include participation in the research and postgraduate teaching programme of the Institute and liaison work both within the Institute and with external organisations. Experience is desirable in one or more of the following areas: dynamics of transportation systems, automobile propulsion systems, data analysis, simulation or mathematical modelling of dynamic systems. Salary will be either on the Range IB scale: £2766 x £204-£3990 p.a. or on the Range 1A scale: £3174-£5418 p.a., starting point not exceeding £4194 p.a. the appointment is for an initial period to 31 October, 1978. Further particulars and application forms from the Academic Registrar, University of Warwick, Coventry CV4 7AL, quoting Ref. No: 45/4F/76. Closing date for receipt of applications is 9 July, 1976.

THE UNIVERSITY OF SHEFFIELD

Department of Building Science

Applications are invited from men and women for a post of

LECTURER IN BUILDING SCIENCE

to join a technological team concerned with environmental design in architecture and planning and to specialise either in climatic aspects of building design with special reference to solar energy exchanges or in the daylighting and artificial lighting of buildings. Candidates must have a good honours degree in an appropriate subject and research or practical experience in the selected field; appropriate environmental research experience outside the field of Building Science will be considered.

Initial salary in range £3174-£4602 on scale rising to £6446.

Particulars from the Registrar and Secretary, the University, Sheffield S10 2TN to whom applications (5 copies) should be sent by 7 July, 1976. Quoting Ref. R.433/H.

Severn Trent Water Authority invites applications from men or women for the following posts within the Directorate of Scientific Services.

Fisheries Biologist

Ref 02/06/1/C94

£2850 - £3567 pa

This is an 18 month appointment to the Craig Goch Ecological Investigation Team. Applicants should be Graduates in Applied Biology or Zoology, preferably with experience in fisheries biology. He/she will work as a member of a team engaged in the ecological and fisheries aspects of inter-river transfers and the use of large reservoirs for river regulation.

The post is based at Malvern but the duties will involve extensive field work. Salary will be dependent upon qualifications and experience.

Quality Control Officer (Groundwater)

Ref 02/06/2/Q79

£4650 - £5016 pa

Quality Control Assistant (Groundwater)

Ret 02/06/3/Q80

£1290 - £2745 pa

Based at Coleshill in the Quality Control Section. The Groundwater Unit provides advice on all aspects of groundwater quality, particularly with regard to:- a) the likely polluting impact of waste disposal and the preparation of the Authority's observation on site licence consultations, b) the preparation of policy documents on aquifer protection, c) monitoring groundwater quality.

Applicants for the Senior post should be qualified geochemists with appropriate experience. Applicants for the Assistant post should be college or university leavers with qualifications in geochemistry and salary will depend on age, qualifications and experience.

Application forms are available from:
The Regional Personnel Manager,
Severn Trent Water Authority,
Abelson House, 2297 Coventry Road,
Sheldon, Birmingham B26 3PU.
Closing date 1st July 1976.

SEVERN TRENT WATER

RESEARCH ASSISTANT

Applications invited from graduates to co-ordinate, edit and collate the results of a team of cell biologists, examining human synovia and producing cytochemical bioassays. Work involves assisting with preparation of articles for publication, investigation of literary references and development of teaching aids. The post does not call for a scientist although knowledge/experience of rheumatological research useful. Ability to type and knowledge of French of advantage.

Salary £2800-£3300.

Apply Secretary, Kennedy Institute of Rheumatology, Bute Gardens, London, W6.

UNIVERSITY OF SOUTHAMPTON

Faculty of Medicine
Human Morphology
RESEARCH ASSISTANT

required for experimental investigations on the immunology of the pregnant uterus. Previous experience in an immunological field is desirable. Appointment for one year in first instance.

For further details contact Dr S. Peel, Human Morphology, Southampton 559122 ext. 8237. Salary on scale £2766-£3990.

Applications giving a brief curriculum vitae should be sent to Mr C. W. L. Swann, The University, Southampton SO9 5NH, quoting reference 653/A/NSc.

THE CHEMICAL SOCIETY

EDITORIAL STAFF

Chemistry graduates are required for editorial work on the Society's publications. A good degree or equivalent qualification is essential and proved ability to write in clear, concise English will be an asset. Further particulars and application form may be obtained from the Personnel Officer, The Chemical Society, 30 Russell Square, London WC1B 5DT.

OVERSEAS VOLUNTEER WORK

in Mauritania for medical laboratory technicians. Difficult, isolated conditions. Diploma or certification with two years' experience fluent French or Arabic. Two year assignment at $80/150 a month plus all expenses including travel. Send resume to: International Voluntary Services, 1555 Connecticut Ave NW, Washington DC 20036.

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PALMER RESEARCH LABORATORIES LTD

ORGANIC CHEMISTS

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We have recently moved into new laboratories and have vacancies suitable for chemists, preferably aged between 20 and 30, to join teams engaged in the investigation of synthetic routes to fine organics and pharmaceutical intermediates. There will also be opportunity to obtain experience in the development of laboratory scale processes to intermediate scale production. Candidates should hold a degree, or equivalent, or have relevant experience.

Our laboratories, situated on the North Wales coast, are within easy reach of Chester, Liverpool and Manchester. We offer a varied and interesting career with competitive salary and attractive fringe benefits.

Please write or telephone for application form to:

Mrs P. M. Williams,
Palmer Research Laboratories Limited,
Mostyn, Holywell,
Clywd, CH8 9HE, North Wales.
Telephone Number MOSTYN 651

ANALYTICAL CHEMISTS/TECHNICIANS

International company, market leaders in the production of speciality dyestuffs, require male and female analysts for their modern laboratories at Hounslow.

The work of the department deals with the comprehensive analysis of high quality organic and inorganic colourants used in the food, pharmaceutical and cosmetic industries and applicants in the 20–30 years age group should be educated to Pass Degree, HNC or ONC level in Chemistry with experience, or the desire to obtain experience, in most classical analytical techniques including IR and UV/Visible Spectrophotometry, Atomic Absorption Spectrophotometry, HPLC and GLC.

Versatility and initiative are essential requirements which will be reflected in the attractive salaries offered and other conditions of employment are first class.

Candidates wishing to join a progressive department making a vital contribution in an expanding organisation are invited to write with brief details to:-

The Personnel Manager,
Williams (Hounslow) Limited
Greville House, Hibernia Road,
Hounslow, Middlesex.

Experimental Officer

There is a vacancy for an Experimental Officer in a team of Biochemists working on the mode of action of insecticides. The work entails detailed studies of biochemical systems peculiar to insects and involves the use of radioisotopes, enzyme kinetics and studying the metabolic fate of compounds in insects.

He or she should have a Degree in Biochemistry or HNC qualification backed by 2/3 years of proven industrial experience. A knowledge of insect physiology would be an advantage.

We offer good salaries and fringe benefits including Membership of the ICI Profit Sharing Scheme and Pension Fund. A staff restaurant and a recreation club are on the site. Subsidised coaches are run to and from Jealott's Hill, Bracknell and Maidenhead. If you are interested in this vacancy, please write for an application form to:

Mr S. R. Stephenson, Personnel Officer,
ICI Plant Protection Division,
Jealott's Hill Research Station,
Bracknell, Berks

ICI Plant Protection Division

Editor

Longman Group Limited have an editorial vacancy at their main offices in Harlow, Essex. The position is in their African Publishing Division and involves working with the Science and Mathematics Publisher. Applicants should have either a science or mathematics degree and an interest in or experience of African affairs would be an advantage. Publishing experience would be useful, but is not considered essential.

For further details and application form please write or telephone:

Mrs S. Etherington, Personnel Officer
Longman Group Limited
Longman House, Burnt Mill
Harlow Essex
Tel: Harlow (0279) 26721 Ext. 29

Longman

Librarian/ Assistant Information Officer

W. R. Grace Limited, the UK subsidiary of an international chemical company has a vacancy within the Information Department of its technical centre, located in pleasant surroundings at St. Neots, Cambridgeshire.

This department serves the staff of the centre who are responsible for developing new products in the plastics and rubber sealants field for manufacturers in various locations around the world.

The successful candidate would, after training, handle day-to-day enquiries, literature searches and participate in producing a current awareness service and operate a computer base retrieval system for company reports.

It is advantageous to have some experience in this field but the post is also suitable for a newcomer to information work preferably with a Degree or ALA qualifications. A working knowledge of a modern European language would be an advantage.

The position offers an excellent salary and fringe benefits including a company pension scheme, free life assurance, subsidised canteen and a Sports and Social club. The technical centre operates on a flexible working hour system.

Write for an application form giving brief details of your career to date to **The Personnel Department, W. R. Grace, Limited, Cromwell Road, St. Neots Lane, Huntingdon, Cambridgeshire.** Telephone Huntingdon (0480) 72681.

GRACE

Automotive Division, Battery Separator Division, Central Services Division, Construction Division, Container Division, Davison Division, Financial Services Division, Industrial Service Chemicals Division, Letterflex Division, St. Neots and Container Equipment Centre (C.E.C.), Park Royal, Container Technical Centre (C.T.C.), Packaging Division, Rexoiin-Detsrex Division.

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GROUP LEADER

A laser technologist is required to lead a R & D Group to be located in the Home Counties to develop laser devices and associated systems. The Company, which has been successfully selling lasers internationally since 1970, is planning expansion of its product range. Applicants should have practical experience of laser technology and possess a good technical background. Salary, in line with experience and qualifications, will be attractive with appropriate fringe benefits. **Applications to Box No. D123.**

Science Museum

ASSISTANT KEEPER-AERONAUTICAL COLLECTION

. . to take charge of the collection and its maintenance, and be responsible for its development in order to illustrate the history of, and current practice in, aeronautics. Work also includes making recommendations for obtaining new material, preparing descriptive labels and writing handbooks.

The successful candidate will be expected to study the collection intensively and become a recognised authority in this field, and maintain contacts with industry to keep in touch with technological developments.

Candidates should normally have a degree with 1st and 2nd class honours in a relevant subject or an equivalent or higher qualification, and must have the ability to write clearly on a technical subject. Relevant experience in the aviation or airline industry or with the Services desirable; a good knowledge of, or interest in, other forms of transport advantageous.

Salary (Inner London): as AK Grade I £5180 – £7885 or AK Grade II £3170 – £4675. Level of appointment and starting salary according to age, qualifications and experience. Non-contributory pension scheme.

For further details and an application form (to be returned by 6 July, 1976) write to Civil Service Commission, Alencon Link, Basingstoke, Hants RG21 1JB, or telephone Basingstoke (0256) 68551 (answering service operates outside office hours) or London 01-839 1992 (24-hour answering service). Please quote ref. G(11)382.

Problem solving Instrument Technician

We're looking for a man or woman with practical experience of physics, electronics or electrics and preferably instrument making.

Based at our Ink Development Laboratories near Orpington, Kent, you'll be responsible for designing, developing and constructing instruments to evaluate new printing inks. You'll also be expected to develop other equipment connected with the actual printing processes and to service existing scientific instruments.

It's challenging work which demands someone who is imaginative, creative and clear thinking. When we find that person, we'll reward them well—with a competitive salary and substantial fringe benefits. Future prospects are good too—as you'd expect from a major international company like Coates which is continually expanding its market for printing inks, industrial finishes, synthetic resins and litho plates.

Please write immediately giving full c.v. to:—

B. Meadow-Smith,
Coates Group of Companies,
St. Mary Cray,
Kent.

G.K.BUREAU

HOSPITALS/RESEARCH/INDUSTRY need Experienced ONC/HNC/BSc/State Registered Technicians & Research Assistants.

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Break Out!

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- Use your scientific and technical knowledge in a more socially relevant way?

You could do this – as a Professional Services Representative – visiting laboratories, hospitals, etc., and discussing products on a technical basis. The work is demanding but satisfying.

You would have an attractive salary and car, and other excellent benefits. Then write or phone (using our FREE POST – no stamp required):

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Department of Botany and Microbiology

RESEARCH TECHNICIAN

(Grade 3)

required from 1 September, 1976 to collaborate in a three-year study of obligately anaerobic bacteria. Previous experience in Microbiology, Biochemistry or applied Biology desirable. Salary on the Scale £2325 to £2655 p.a.

Application forms and details obtainable from the Registrar, The University College of Wales, King Street, Aberystwyth SY23 2AX. Closing date 9 *July, 1976.*

IRELAND

FORENSIC SCIENTIST

required in the Department of Justice

Essential: A recognised 1st or 2nd class honours university degree in an appropriate Biological Science subject and satisfactory relevant experience (about five years, experience will be necessary).

Salary: £5260–£6310 Entry up to the maximum.

Upper age-limit: 35 years.

Closing date: 9 July, 1976.

For further details and [illegible] to the Secretary (D), Civil Service Commission, 1 Lower Grand Canal Street, Dublin 2.

UNIVERSITY OF NOTTINGHAM

Department of Zoology

Applications are invited for the post of

LECTURER

in the above department. The appointment will date from 1 October, 1976, and the salary will be within the Lecturers scale £3174-£6446 per annum, though the appointment will initially be made within the first three points, £3174, £3378, £3582.

Preference will be given to applicants with research interests in either Parasitology or Neurobiology. Candidates who applied for the previous vacancy in this Department, who wish to be considered for this new position should inform the Staff Appointments Officer at the address below.

Further details and application forms, returnable not later than 30 June, 1976, are obtainable from the Staff Appointments Officer, University of Nottingham, University Park, Nottingham NG7 2RD, quoting ref. no. 485.

DEPARTMENT OF BOTANY AND MICROBIOLOGY

LABORATORY TECHNICIANS GRADE 3

required as follows:

1. To assist with experiments in plant tissue culture, in maintaining a small research laboratory and with student practicals in virology. Experience in tissue culture or microbiology an advantage but not essential. Quote reference CD4.
2. To assist in research on the topography of bacterial membranes and also on control of amino acid biosynthesis in bacteria. Experience of microbiological techniques an advantage. Quote reference CD5.

Salary depending upon experience, in the range £2325-£2655 plus £465 London Weighting. Application forms from Personnel Officer (Technical Staff) University College London, Gower Street, London WC1E 6BT.

BRUNEL UNIVERSITY

Department of Polymer Science

TECHNICIAN GRADE 5

with Engineering background and experience in the Polymer Science or Materials fields, required to assist in the running of the Plastics Production Machinery laboratory. Successful applicant will be required to advise and assist with modification and design of equipment, e.g. injection moulding tools and die technology, and the preparation of drawings. Applicants should preferably be educated to HNC standard or equivalent.

Salary scale £2751-£3207 plus £275 London Weighting.

Four weeks' annual leave plus additional days at Christmas and Easter.

Write for application form to Assistant Secretary (Establishment), Brunel University, Uxbridge, Middlesex, or telephone Uxbridge 37188, extension 49. Closing date: 2 July.

UNIVERSITY OF ST. ANDREWS

Department of Physiology

Applications are invited for a new lectureship in the Department of Physiology, tenable from October 1976. The successful applicant would be expected to have a PhD in Physiology or an allied subject, several years of postgraduate experience, and be established in a research field. The applicant will be expected to teach Medical and Science students up to Honours level, supervise postgraduates, and pursue independent research. Salary at appropriate point on scale £3174 to £6446, starting sslary probably not above £4602; FSSU/USS.

Applications (two copies preferably in typescript) with the names of three referees should be lodged by 31 July. 1976 with the Establishments Officer of the University, College Gate, St. Andrews, Fife, from whom further particulars may be obtained.

Research Chemists

Two vacancies have arisen in the Chemistry Department of the Research Division of Wilkinson Match.

Organic Chemist

To lead a small team studying the properties of hair and skin, and their reactions and interactions when subjected to mechanical, physical and chemical stresses of the type that might relate to the shaving process.

The successful candidate will have a sound background in chemistry and will probably have specialised in organic or physical organic research chemistry. Some knowledge of biological techniques could be an advantage, but a flexible approach to research and an interest in multi-disciplinary problems are more important than directly relevant experience.

The position will appeal to those who have already moved, or now wish to move, outside the realms of pure organic chemistry and who want an opportunity to apply their expertise to more general scientific problems.

Further information on the potential scope of this important position will be available at interview.

Physical Chemist

To undertake, as a member of a small specialist team, investigations into the flow of fluids in porous media, solid-liquid interfacial properties, capillarity and related topics. The projects undertaken by this team require a sound theoretical approach and an interest in interpreting results in a quantitative manner.

The successful candidate will be aged about 24-30, and will either be a graduate with specialist knowledge or experience in surface chemistry, or of post-doctoral level with relevant research experience.

Applications, with curriculum vitae to:—

Personnel and
Administration Manager,
Wilkinson Match Limited,
Research Division,
Poyle Road,
Colnbrook,
SLOUGH, SL3 0HA.

Or Telephone:—
Colnbrook 3811 Ext. 25.

Wilkinson Match

Graduate Chemist

A vacancy exists in the Inorganic Production Department of BDH Chemicals Ltd. for a graduate chemist with a good background knowledge of inorganic chemistry and possibly some industrial experience.

The successful candidate will be expected to take charge of a section within the Department and to make a significant contribution in the areas of product improvement and new manufacturing technique.

Applications should be made in writing to:—

BDH

The Personnel Manager,
BDH CHEMICALS LTD.,
Broom Road, Poole, Dorset, BH12 4NN.

UNIVERSITY OF NOTTINGHAM

Medical School

A CHIEF TECHNICIAN

is required in the Department of Therapeutics, based at the Nottingham City Hospital. Applicants should be graduates or have a professional qualification and be State Registered in order to deal with patients. Candidates should have experience in Biochemistry or Haematology and in handling technical staff. The person appointed will also be expected to carry out general administrative duties within the department.

Salary per annum, minimum £4767-maximum £5421, on Whitley Council scale. The commencing salary will be dependent on age, experience and qualifications. Application forms may be obtained from Mr F. C. Treeby, Chief Technical Adviser, Medical School. Completed forms should be returned to the Establishment Officer, University of Nottingham, University Park, Nottingham NG7 2RD, giving the names of two referees.

Paper Development Technologist

Our client, a major international organisation, have established their name in the graphic communications equipment field, and have an exceptionally interesting career opportunity available in their Engineering Development Organisation in East Hertfordshire.

A vacancy exists for a Paper Development Technologist to work on the property requirement of paper and other sheet materials that are used in our clients wide range of machines. This will involve analysis of specific paper problems, design of tests and experiments and a strong liaison with paper manufacturers.

This post offers a challenge for those wishing to extend their paper mill experience to the practical problems of consumer products. A degree in Paper Technology, Physics or Chemistry is preferred, but more important, at least three years practical paper mill experience covering paper technology aspects.

The Company offers above average salaries and fringe benefits which include generous assistance with relocation expenses where appropriate.

Please write for an application form to position number HKP5418 Austin Knight Limited, London W1A 1DS. Applications are forwarded to the client concerned, therefore companies in which you are not interested should be listed in a covering letter to the Position Number Supervisor.

AK ADVERTISING

UNIVERSITY COLLEGE LONDON

COLLOID SCIENTIST

required for SRC-funded project on the filtration of aqueous suspensions through fibrous media, involving both experimental and theoretical studies of the deposition of colloidal particles on to inorganic fibres.

The 3-year appointment may be at the post-doctoral level, 1A (£3174-£3582), or at level 1B (£2766-£3174)+£450 p.a. London Allowance. In the latter case, registration for a higher degree may be possible.

Applications, with details of academic career, qualifications and experience should be sent as soon as possible to: Dr J. Gregory, Dept. of Civil Engineering, University College London, Gower Street, London WC1E 6BT.

TECHNICIAN

required in the PHYSICS DEPARTMENT, Institute of Cancer Research and Royal Marsden Hospital, London SW3 to work in the Radiopharmaceutical Laboratory. The work will involve the measurement of radioactive sources and the preparation of radiopharmaceuticals for a variety of diagnostic and therapy procedures. Previous experience with radioactive isotopes desirable.

Appointee to start in August, 1976.

HNC, University degree in Physics or equivalent qualification. Salary according to age and experience in scale ranging from £2823-£3825 plus £312 London Allowance.

Applications in duplicate naming two referees, should be sent to the Secretary, Institute of Cancer Research, 34 Sumner Place, London SW7 3NU quoting ref.301/B/568.

Research Officer

Physicist/Electrical Engineer

The Research Centre is engaged on a wide range of projects concerned with the utilisation and distribution of electricity, ultimately leading to a more efficient use of our energy resources.

A vacancy exists in the Distribution Section for a theoretical physicist/electrical engineer to work on some of the fundamental aspects of distribution system menagement and the behaviour of system hardware. New Methods of communication, making use of the cable network are involved. The problems of interfacing these with protection and control devices remain to be tackled.

The ability to make a sound scientific contribution without preconceived ideas is important.

Applicants aged 21 - 27 (men or women) should have a good honours degree in a relevant discipline. Previous experience in the field is not essential.
Starting salary will depend on age, qualifications and experience but will be within the range £3042 - £5292 with ultimate prospects over £7000. NJB conditions of service - Electricity Supply Industry.

Please write, quoting reference. ./460 to Head of Personnel Services,

Electricity Council
Research Centre
Capenhurst Chester CH1 6ES

THE NEW SOUTH WALES INSTITUTE OF TECHNOLOGY
(SYDNEY, AUSTRALIA)

Senior Lecturer/Lecturer

(School of Computing Sciences)

The New South Wales Institute of Technology is a corporate institution of higher education established to provide a wide range of professional courses for those entering or already employed in industry, government and technological fields. The School of Computing Sciences offers a Bachelor's degree course in Computing Science, a postgraduate diploma in Data Processing and a Master's Degree by research work and thesis. The School has an academic staff of 23 engaged in lecturing, research and consulting to industry. Successful applicants will have a higher degree and preferably some lecturing experience. Demonstrated ability and interest in operating systems, data communications, large system development and management, or on-line data acquisition/control would be of value. The appointees will conduct classes, supervise research and projects, and actively pursue research or consulting.

Salaries are the same as University salaries at:
Senior Lecturer: $A17 569 – 20 421
Lecturer: $A12 835 – 17 228

Fares and a contribution toward removal and initial accommodation expenses are provided for overseas appointees. A Housing Loan Scheme is also available.

Applications close on 30 July, 1976. There will be opportunity for interview in London in September 1976. Applications should include transcripts of academic qualifications and applicants are also asked to arrange for three confidential referees' reports to arrive by the closing date. Applications and referees' reports are to be sent to:

The Agent-General for New South Wales,
N.S.W. Government Offices,
66 Strand, LONDON WC2N 5LZ, ENGLAND.

NATURAL ENVIRONMENT RESEARCH COUNCIL

SYSTEMS ANALYST/ COMPUTER PROGRAMMER

is required to join a small NERC team to be stationed at the Science Research Council's Rutherford Laboratory at Chilton, Oxon.

The successful candidate will work in a small team assisting scientists in the NERC institutes throughout the UK in the use of the large SRC and NERC computers by giving advice on and assistance with communications and available hardware and software, including operating systems. The team will also be responsible for the development and support of major software packages needed by NERC scientists.

QUALIFICATIONS/EXPERIENCE:

Applicants will be expected to have a degree of equivalent qualification in a scientific or engineering subject and be experienced in FORTRAN or APL; familiarity with large IBM, ICL or UNIVAC computers would be an advantage.

Appointment will be to the grade of Scientific Officer (£2149-£3527) or Higher Scientific Officer (£3254-£4454) according to age, qualifications and experience. A supplement of £6 a week will also be paid.

Non-contributory Superannuation Scheme.

Application forms are available from A. Cooke, Establishments Division, Natural Environment Research Council, Falcon House, Fleming Way, Swindon SN1 2NG.

Telephone Swindon (0793) 26231 Ext 216. Quoting Reference E2/G2/128.

Closing date for completed applications: 9 July, 1976.

THE UNIVERSITY COLLEGE OF WALES, ABERYSTWYTH

Department of Statistics

Applications invited for the post of

LECTURER

to commence on, or as soon as possible after 1 October, 1976.

Salary on the scale £3174-£6446 p.a.

Application forms and particulars available from the Registrar.

Closing date—15 July.

Department of Chemistry

ASSISTANT FOR DIELECTRICS RESEARCH

To assist and develop new aspects of dielectric studies;. in particular to control and use microwave sweep-frequency and pulsed high-field methods for dielectric studies. Honours graduate in Physics or Electronic Engineering.

Fixed-term appointment from September, 1976 Salary: £2000 p.a.

Application forms from the Registrar, University College of Wales, Aberystwyth to be returned before 2 July, 1976.

UNIVERSITY OF BATH

School of Physics Geophysics Research Group

RESEARCH OFFICER IN UNDERWATER ULTRASONIC

Applications are invited for a Post Doctoral Research Officer or equivalent to join an active group studying Marine Sediments by Ultrasonic methods. Preference may be given to applicants having some experience of Ultrasonic techniques and associated electronics, but other applicants from related disciplines in physics will be considered.

The post is for one year in the first instance, but is renewable up to a maximum of three years. Salary will be in the region, £3174-£5418 according to qualifications, age and experience. Application forms are available from: Personnel Officer, University of Bath, Claverton Down, Bath. Quote Ref: NS 76/71. Closing date is 9 July, 1976.

Overseas Development

Thailand

Population Analyst

Under the direction and supervision of the Chief of the General Demography Section, Population Division, to assemble, evaluate and prepare data for projections of families and households; mould projection model and prepare projection for countries of the region in collaboration with national experts; assist in related research work. Applicants should have a Degree in Social Science and some knowledge of data processing together with experience in demographic projections and research, and in the use of computer in demographic research. Fluent English essential, knowledge of French an advantage. Appointment for 18 months.
Emoluments: current salary plus a tax free overseas allowance in range £980 – £2145 p.a.

Malaysia

Experimental Child Psychologist

At the Regional Centre for Science and Mathematics, Penang, to study children's behaviour in different experimental situations; to find factors which control behaviour; to undertake training courses, lecturing, tutorials in field experimentation including production of teacher training materials. To utilise research experience with children at primary and lower secondary levels; to assist with interpretation of field experiments. Some visits to adjacent countries may be required. Applicants must have a qualification in Educational Psychology and have practical experience in the prescribed duties of the post. Appointment for 2 years.
Emoluments: current salary plus a tax free overseas allowance in range £1055 – £2550 p.a.

Other benefits (both posts) include free family passages, paid leave, children's educational allowances, and free accommodation and medical attention. Superannuation rights may be preserved and all emoluments are paid by the British Government. Applicants should be citizens of the United Kingdom.
For full details please apply indicating the post concerned and giving details of age, qualifications and experience to:—
Appointments Officer,

Ministry of Overseas Development

Room 301, Eland House
Stag Place
London SW1E 5DH

FELLOWSHIPS, GRANTS AND SCHOLARSHIPS

UNIVERSITY OF SOUTHAMPTON

DEPARTMENT OF PHYSICS

RESEARCH FELLOWSHIP

Applications ere invited for a Post-doctoral Research Fellowship in Theoretical Elementary Perticle Physics for an investigetion of theorectical models of the "New Particles". The precise experience of applicants is not critical but familierity with some aspects of quark models or geuge theories is desirable. The Fellowship is teneble for up to three yeers from 1 October, 1976 and the initial salary will be on e range up to £3582 per annum plus USS benefits and ennual increments of £204. Further particulers may be obtained from Mrs J. Jones, Department of Physics, and applicetions with the nemes of two referees should be sent to D. A. S. Coplend, The University, Southampton SO9 5NH by 9 July, 1976, quoting reference 485/R/NS.

PLANT BREEDING INSTITUTE

RANK PRIZE FUNDS POST-DOCTORAL RESEARCH FELLOWSHIP IN CYTOPLASMIC GENETICS

Applications are invited from biochemical geneticists or other suitably qualified persons with an interest in plant genetics to undertake research into cytoplasmic variation and its effects on subcellular metabolism and whole plant development. Experience in plant organelle biochemistry would be an advantage.

The Fellowship, which carries with it some support funds, will be for two years with the possibility of an extension for a third year. Salary will be equivalent to the Senior Scientific Officer Grade, starting at £4185 pa.

Applications, which should include full curriculum vitae and names of two referees, should be sent to Assistant Secretary (Estab), Plant Breeding Institute, Trumpington, Cambridge, CB2 2LQ, by 17 July, 1976.

Further details on request.

ZOOLOGICAL SOCIETY OF LONDON

Wellcome Institute of Comparative Physiology

POST DOCTORAL FELLOWSHIP IN REPRODUCTIVE PHYSIOLOGY

Applications are invited for a post-doctoral research Fellowship awarded for studies in mammalian reproduction tenable from 1 October, 1976. Applicants should have research experience either in (1) semen physiology and artificial insemination, or (2) radioimmunoassay of hormones.

The Fellowship, tenable for three years, carries a salary within the University Lecturer range with FSSU benefits.

Applications in triplicate should be sent to the Establishment Officer, Zoological Society of London, Regent's Park, London, NW1 not later than 8 July, 1976.

Commonwealth of Australia

QUEEN'S FELLOWSHIPS
in Marine Science

To commemorate the Royal visit to Australia in 1970 the Australian Government established the Queen's Fellowships Scheme. Under this scheme up to five fellowships may be awarded each year for full-time research by young scientists of exceptional promise and proved capacity for original work. These awards are tenable at an Australian university or approved research institution normally for two years. Tenure of a Fellowship is expected to commence within nine months of the announcement of the award.

QUALIFICATIONS. Queen's Fellows should have a Ph.D., or equivalent qualifications, or equivalent research or professional experience, in a discipline applicable to marine science. Awards will, in general, be restricted to applicants who are not more than 30 years of age on the date when applications close.

STIPEND. $14,000 (Australian) per annum—increased to $15,098 per annum at age 28 years.

ALLOWANCES. Allowances are payable in respect of a Fellow's dependent spouse ($500 p.a.), each dependent child ($200), superannuation payments (up to 10 per cent of stipend), appropriate insurance coverage and necessary travel expenses.

APPLICATIONS. Persons interested in applying for the above fellowships should obtain application forms and a statement of the conditions of award from the Secretary, Queen's Fellowships Committee, Department of Science, P.O. Box 449, Woden, ACT., 2606, Australia; the Education Liaison Officer, Canberra House, Strand, London, W.C.2., England; or the Consul General, Australian Consulate General, 636 5th Avenue, New York 20, N.Y., 10020, U.S.A. Applications for the next round of awards, which will be announced in December 1976, close at the Canberra address on 1 August 1976.

UNIVERSITY OF KENT AT CANTERBURY
RESEARCH FELLOW IN THE BIOLOGICAL LABORATORY

Applications are invited for an SRC-supported POST-DOCTORAL RESEARCH FELLOWSHIP for research on the biochemistry and enzymology of new oxygenases mediating the biodegradation of synthetic heterocyclic pesticide compounds. The appointment will be for up to 3 years.

Candidates should have or expect to obtain a PhD degree in biochemistry, enzymology or a related field. The initial salary will be £3174 in the range £3174-£3582. Application forms and details may be obtained from the Assistant Registrar, Faculty of Natural Sciences, Chemical Laboratory, The University of Kent, Canterbury, Kent CT2 7NH to whom completed applications should be submitted by 16 July, 1976. Please quote ref A26/76.

WYE COLLEGE
(University of London)
MAFF RESEARCH SCHOLARSHIPS

The Ministry of Agriculture, Fisheries and Food is prepared this year to offer to a suitable candidate a scholarship tenable in the Department of Agriculture, Wye College. The minimum standard for the award of the Scholarship is an upper second class Honours degree in an appropriate subject. The present value of MAFF awards is £1085 pa.

The proposed investigation will be (a) on the utilisation of lucerne or (b) on the agronomy of linseed.

Application by 7 July to Professor W. Holmes, Wye College, Ashford, Kent from whom further particulars may be obtained.

UNIVERSITY OF DURHAM
Department of Geography

Applications are invited from candidates of postdoctoral status for a

RESEARCH FELLOWSHIP

financed by IBM, UK Ltd. The post is tenable from as soon as possible for an initial period of one year to work on the conceptualisation and description of network data in conjunction with Dr D. W. Rhind. Experience in computer methods would be an advantage.

Salary £2766-£3990 on National Range 1A or 1B (depending upon experience and qualifications) plus superannuation.

Applications (three copies) naming three referees should be sent by 30 June, 1976 to the Registrar and Secretary, Science Laboratories, South Road, Durham, DH1 3LE, from whom further particulars may be obtained.

STUDENTSHIPS

UNIVERSITY OF READING
Department of Soil Science

The Department offers a MAFF supported Research Studentship tenable from October 1976, for an investigation of either (a) Naturally occurring nitrification inhibitors, or (b) Soil structure and nitrate leaching. Applications are invited from honours graduates who have, or expect to obtain, an Upper Second class degree in soil science, chemistry or applied chemistry. For (a) applicants with a degree in botany with chemistry will also be considered. Apply to Dr A. Wild, Department of Soil Science, University of Reading, London Road, Reading RG1 5AQ (Ref. M.S.21A).

UNIVERSITY OF YORK
Department of Biology
CASE STUDENTSHIP

An SRC CASE studentship in collaboration with Simon-Hartley Ltd., Stoke-on-Trent, is available for up to 3 years from October 1976 for work leading to a higher degree. The student will join a group working on various aspects of sewage treatment, in which his or her part will be the biological characterisation of activated sludge flocs in relation to the quality of the final effluents. The project will be supervised by Dr M. Davies (York) and Dr J. W. Abson (Stoke). Candidates should have, or expect to obtain, a good honours degree in Biology or Microbiology (with biochemical interests) or in Biochemistry, and should send applications with the names of two academic referees to Dr M. Davies, Department of Biology, University of York, York YO1 5DD, from whom further information can be obtained.

UNIVERSITY OF HULL
Department of Plant Biology
SRC CASE STUDENTSHIP

Applications are invited for an SRC CASE award to study the "Biochemical Properties of the Extracellular Products of Listeria monocytogenes" under the supervision of Dr D. R. Threlfall and I. Leighton (Hull Royal Infirmary). The successful applicant is expected to have experience in biochemical and microbiological methods and to possess a I or II(i) honours degree in one of these or related subjects.

Applicants should submit curriculum vitae and the names of two referees to Dr D. R. Threlfall, Department of Plant Biology, The University, Hull NU6 7RX.

PORTSMOUTH POLYTECHNIC
Department of Biological Sciences
RESEARCH STUDENTSHIPS

(a) One SRC studentship for projects in Parasitology or Mycology.

(b) One SRC CASE studentship for an algologist. Topic "The Importance of diatoms as marine fouling organisms".

(c) Six SRC Advanced course studentships for the MSc course in the Biodeterioration of Materials. Closing date 5 July.

Further information and application forms from Dr E. B. G. Jones, Department of Biological Sciences, Portsmouth Polytechnic, King Henry I Street, Portsmouth, Hants.

THE UNIVERSITY OF LEEDS
ASTBURY DEPARTMENT OF BIOPHYSICS

Applications are invited for the following 3-year postgraduate awards:—

Wellcome studentship for conformational studies of small molecules and their interactions with proteins, by the use of an interactive computer display system.

CASE studentship in association with Fison's Ltd. for structural studies of anti-allergic drugs.

SRC *and* MRC *studentships* for: crystallographic studies of enzymes; spectroscopic studies of enzymes and membranes.

Candidates are expected to obtain a good honours degree in physics, chemistry, biochemistry or a related subject; applications, including the names of two referees should be sent as soon as possible to Professor A. C. T. North, Astbury Department of Biophysics, University of Leeds, Leeds LS2 9JT.

UNIVERSITY OF BIRMINGHAM

Department of Chemistry

POSTGRADUATE RESEARCH STUDENTSHIPS

Science Research Council CASE studentships are available for applicants with a good Honours degree in Chemistry or other appropriate subject, or an equivalent qualification, for research on the following projects:

1. Synthesis of enzyme-drug and enzyme-metabolite conjugates for enzyme immuno-assay: Prof S. A. Barker/Koch-Light Laboratories, Limited.
2. Studies of polymerisation kinetics and the development of metal (Ziegler) catalysts for stereoregular polymerisation: Prof R. N. Haward/ICI (Plastics) Ltd.
3. The composition and surface properties of colliery 'tailings' and the development of agricultural and industrial uses: Dr M. H. B. Hayes/National Coal Board.
4. Studies of the Orientation of organic molecules adsorbed in the interlamellar spaces of expanded clay minerals: Dr M. H. B. Hayes/Rothamstead Experimental Station.
5. Synthesis of nucleosides and nucleotides from 5-flouro-2″-deoxyuridine for investigation as potential anti-cancer agents: Prof A. S. Jones/Roche Products.
6. Synthesis of nucleoside and nucleotide derivatives for the preparation of polynucleotide analogues, and studies of their anti-viral and other biological properties: Prof A. S. Jones/G. D. Searle Ltd.
7. Studies in organic electrochemistry relating to the role of metal ions in the electrochemical reduction of brightening agents: Dr A. E. Pedler/W. Canning Ltd.

An NERC studentship is also available to a good honours graduate or MSc in chemistry, biochemistry, geochemistry, or chemical engineering, to study structures of humic substances in fresh water environments: Dr M. H. B. Hayes.

Studentships may also be available to suitably qualified applicants for research in general organic, physical, inorganic, and analytical chemistry.

Applications, including the names of two referees, should be sent to Miss M. Jewes (Administrative Assistant), Department of Chemistry, Birmingham University, Birmingham B15 2TT.

LOTHIAN REGIONAL COUNCIL

Napier College of Commerce and Technology

SRC CASE RESEARCH STUDENTSHIP IN THE DEPARTMENT OF CHEMISTRY

Applications are invited from persons suitably qualified under SRC regulations for a CASE Research Studentship leading to the degree of PhD.

The project would entail investigations into the mechanisms of plumbosolvency in drinking water and close co-operation with the Water Supply Services of the Lothian Region.

Applicants who should have a good honours degree or its equivalent in chemistry should apply to the Academic Registrar (NT), Napier College of Commerce and Technology, Colinton Road, Edinburgh, EH10 5DT.

CITY OF BIRMINGHAM POLYTECHNIC

Department of Mechanical and Production Engineering and Elecrtical Engineering

Research Studentship

Applications are invited from honours graduates in mechanical, production or electrical engineering for an SRC Research Studentship. The Studentship is available from 1 October 1976 and, in normal circumstances, will be tenable for three years. The successful applicant will be required to carry out research on the development of low cost control systems for machine tools using microprocessors, and will join an inter-departmental group working in this field.

Application, including a curriculum vitae and the names and addresses of two referees, should be sent as soon as possible to the Secretary of the Department of Mechanical and Production Engineering, City of Birmingham Polytechnic, Perry Barr, Birmingham B42 2SU.

Initial informal discussions by telephone may be made, if required, by contacting **Dr F. Arthur or Dr W. J. Wilber, Tel: 021-356 6911.**

ANIMAL VIRUS RESEARCH INSTITUTE

Pirbright, Woking, Surrey

WELLCOME FOUNDATION STUDENT

Applications are invited from Science students graduating this year for a Wellcome Foundation Studentship tenable for three years at the Animal Virus Research Institute. The successful applicant will join a small group working on the biochemical mapping of picornavirus RNAs. In particular the relationship of foot-and-mouth disease virus RNA to the biological and serological properties of the virus will be studied.

The applicant will be expected to submit his work for a PhD degree. The value of the Studentship is £1494 pa. Registration fees, travel allowances etc will also be paid. Applications should be made to Dr F. Brown at the above address.

THE OPEN UNIVERSITY

Research Studentships in Neurochemistry

Applications are invited for a MRC research studentship leading to a PhD, to work with Professor S. Rose at the Brain Research Group on cellular compartmentation of metabolism and neurochemical changes during development and learning. Applicants should have, or expect to gain in 1976, a first class or an upper second class honours degree in biochemistry. Further particulars and application forms are available from the Higher Degrees Office RSN 1, The Open University, PO Box 49, Milton Keynes, MK7 6AD. Closing date: 30th June 1976.

THE UNIVERSITY OF SHEFFIELD

Department of Obstetrics and Gynaecology

AN MRC POST-GRADUATE STUDENTSHIP

is available in the above department. A first class or good second class honours degree in an appropriate biological science is required. The proposed work will be clinically orientated and will relate to studies of uterine activity and the welfare of the fetus in labour. An interest in data handling and processing would be an advantage. Applications to: Dr Sheila Duncan, Senior Lecturer, Department of Obstetrics and Gynaecology, Clinical Sciences Centre, Northern General Hospital, Sheffield, S5 7AU. Tel. 387253 ext 442 (from whom further particulars can be obtained). Quote Ref: R430/H.

UNIVERSITY OF SOUTHAMPTON

Department of Civil Engineering

CASE STUDENTSHIP

A research student is required to work on a joint project to be carried out at the University of Southampton and Marchwood Laboratory (CEGB). The successful applicant will work on aspects of Sinite Element solutions of the Navier Stokes Equations under the supervision of Doctor C. A. Brebbia (University of Southampton) and Doctor I. Castro (CEGB). Preference will be given to candidates who have interests in both numerical techniques and fluid mechanics. The successful applicant will be required to register for a higher degree of the University.

Applications should be sent to Mr M. A. McSweeney, Department of Civil Engineering, University of Southampton SO9 5NH.

LECTURES, MEETINGS AND COURSES

MSc Course in Materials Science

Studentships up to £1500 are available for honours graduates in science or engineering who wish to specialise in the materials field.

Academic Registrar
Thames Polytechnic, London SE18

MINI-UNIVERSITY: Towards an Alternative Society.
Swindon—August 2-14

12 days of guided study—Energy, Health, Housing, the Arts.

For information write:
Alternative Society, 9 Morton Avenue, Kidlington, Oxford.

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Dateline

SERVICES

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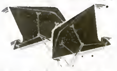

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CAMBS. TEL SLEPE (048 082) 485

APPOINTMENTS WANTED

POST GRADUATE (26) biologist, PhD entomology, seeks post home or abroad. Box D124.

BOOKS AND PUBLICATIONS

ET DATABANK on Phobos 75p, Destiny Mars £1. Downs Books, Caterham, Surrey.

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Ariadne

■ Karl Marx, the archetypal doomster, is said to have revised his predictions in the light of the California goldrush and the rapid development of the Middle West wheat lands. What would he have made of the modern California electronics boom? A new book, *The Innovation Millionaires*, by Gene Belinsky pinpoints the new El Dorado. It lies in Santa Clara County where "there are at least 100 millionaires—and possibly as many as 500. Many of them are in their early thirties . . . Nearly 1000 pioneering technology companies, along with numerous service and supplies firms are clustered in the area, forming the densest concentration of innovative industry that exists anywhere in the world." What is the secret? Belinsky offers a number of causes: inter-company cooperation ("almost Japanese in its closeness") entrepreneurial zest rather than Eastern-style money management. How Adam Smith would have loved it.

■ He would have been relieved, too, to learn that Herman Kahn is fighting back against those latterday doomsters, the Club of Rome. His latest book, *The Next 200 Years*, scoffs at the energy worriers. Perhaps we'll have to put up with coal for a while but by 2176 at the latest we'll be firing on all cylinders with fusion, geothermal and solar energy. Kahn's people have great fun with previous prophecies that came unstuck, eg the US Geological Survey's 1891 prediction that there was little or no chance of oil being found in Texas. Feeding 15 000 million people? No problem. "Food would be extracted from almost any organic matter, including wood, leaves, cellulose, petroleum and even urban and agricultural wastes." Nor any shortage of cash. Indians in 2176, according to the doctrine, will be better off in GNP per capita than the Americans in 1976. Kahn's confidence, however, is a bit too brash even for a *Fortune* (June 1976) reviewer who is less sanguine about coping with a global population of 15 000 million. What we need is for one or two of those young Santa Clara millionaires to take a sabbatical in Bangladesh. The experience would be salutary for both sides.

■ Jacques Monod was the darling of the non-Communist Left in France. *Le Nouvel Observateur*, honouring his memory, revives quotations from an earlier interview which preserve the flavour of the man: "In science, self satisfaction is death. Personal self satisfaction is the death of the scientist. Collective self satisfaction is the death of research. It is restlessness, anxiety, dissatisfaction, agony of mind that nourish science." And: " 'Everything that exists in the Universe is the result of chance and necessity'—when I found that quotation in Democritus I almost had tears in my eyes; to think that it had been written 2500 years ago!"

■ My request (27 May, p 504) for an explanation of The Doorbell That Rang by Itself has produced this response from Simon Goodman of the University of Sussex:

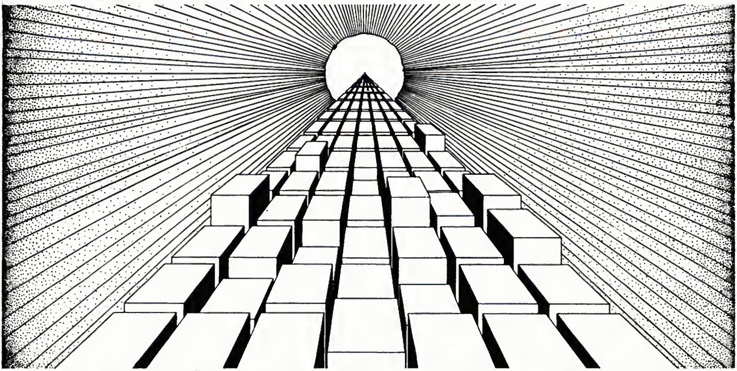
Salts in water, good conductor
Good enough to short a bell,
Trickle slowly down the contacts
One drop, one ring, no pixie spell.
Wet corroded little contacts,
Shoved together stick, and—well—
Banging is a quick solution
To relieve acoustic hell,
Comes the daytime, dries the contact.
Bells won't ring until they're asked.
(Only wet if cool and windy,
Shady doorways do this task)
And so, in short your friend's frustrations
Are clearly due to condensations.

■ Environmentalists who take hope from the drop in car sales throughout much of western Europe will find no comfort in the situation east of the curtain. *Le Monde* (6-7 June) reports that a small ad in one of the Budapest dailies ran: "Divorced woman, age 44, well preserved, cultured, cheerful disposition, seeks ideal man without bad habits. She has a small flat (all mod cons) in the centre of Budapest. Priority will be given to applicants who are car owners." The reports tells of a crowd gathering round a showroom displaying the latest Soviet, Czech and East German models, delivery dates towards 1981. The old petrol slogan, "Get Away people" would, of course, have a rather different connotation in this case.

■ The neutrino telescope — 100 000 gallons of dry-cleaning fluid at the bottom of a gold-mine—has a zany magnificence which fascinates my optotropic friend Daedalus. He now matches it with an almost equally bizarre astronomical instrument. An optical telescope is just a device to separate light coming from one direction from that coming from another; the closer the directions it can resolve, the better. Now solids interact with light only if its electric field (always exactly at right-angles to its direction of travel) can induce some electronic motion or current in the solid. Daedalus recalls the recent synthesis of "platinum chain" compounds whose crystals are threaded by long straight lines of adjacent platinum atoms: the ultimate in thin platinum wire, for the crystals can conduct electricity down these "wires". The crystals, like any metallic conductor, will reflect light because its electric field will induce currents in the "wires". But, says Daedalus, consider light hitting a crystal *exactly* parallel to the wires. Its field is at right-angles to them, no currents will flow in them, so it will traverse the crystal unchanged. For this single direction the crystal must be not reflecting, but transparent. So Daedalus's hyper-resolving telescope is just a vast single crystal of dipotassium tetracyanoplatinate chloride held in gimbals. One surface faces the heavens; the opposite side is blanketed with photomultipliers. The only light penetrating through to them comes from the one unique direction in which the crystal is transparent. Sensitivity and resolution can be increased without limit just by making the crystal bigger. Galaxy-hunting, star-counting and all sorts of cosmological enterprise should be revolutionised. And on a humbler scale, the new principle also makes possible the ultra-greenhouse, with thermos walls and a single-crystal roof tracked always to face the sun. Solar radiation pours through unchecked, but radiation inside has randomly distributed directions and is perfectly reflected back by the walls and almost perfectly by the roof. In principle the inside should reach solar temperature—6000°C. Even allowing for losses, the solar blast furnace looks feasible.

I guess we'd better check out that radiation suit before your next flight, George.

Energy research is the growth industry of this decade.



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